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CANTILEVER BRIDGE OVER THE SEINE AT PASSY; METROPOLITAN RAILWAY OF PARIS.

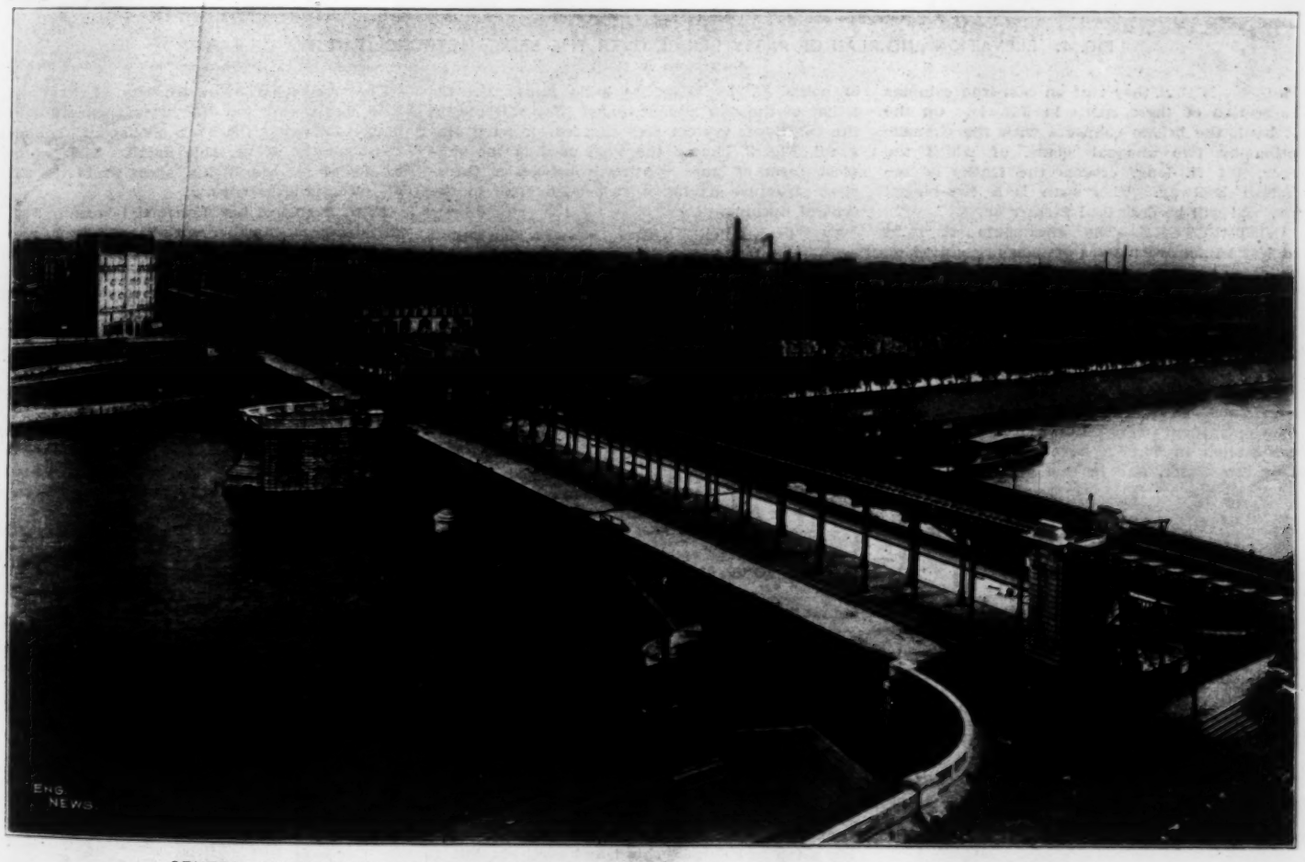
By R. Bonnin.*

The south branch of the Metropolitan belt line, in Paris, France, connecting the Place d'Italie with the Place de l'Etoile, crosses the Seine at Passy, on the site of a previously existing highway bridge. The old bridge was insufficient both in width and strength, and it was necessary to construct a new crossing. The new bridge is described in the following. The writer has previously† described the interesting arrangements used for moving the old bridge to a location alongside the site, to serve as temporary crossing, as well as the method of removing the old piers, pulling them up by hydraulic jacks.

The new Passy bridge is one of the most important structures of the Paris Metropolitan Ry. Others of equal importance are the Austerlitz bridge, described in a recent article,* and the underground crossing of the Seine between the Chatelet and the place Saint-Michel, now under construction.

GENERAL DESCRIPTION.—With its approach viaducts the new Passy bridge is 1,410 ft. in length, between the stations Quai de Passy and Quai de Grenelle. The approach viaducts on the two banks differ in character, and each has some interesting features of construction. The bridge itself, however, is of primary interest. It crosses two arms of the Seine separated by the narrow Ile des Cygnes, and thus consists virtually of two bridges. The two bridges are of similar arrangement in every respect, but that over the main branch is somewhat longer than the other. Both of them are double-deck structures, having a wide main deck for vehicles and pedestrians, and a two-track upper deck for the Metropolitan Railway.

The bridge across the main channel has three spans, the middle one 177 ft. (54 m.) between centers of piers, and the two shore spans each 95 ft. (29 m.) between center of pier and points of support on the abutment. The bridge across the secondary channel has a middle span of 138 ft. (42 m.) and two side spans of 75 ft. (23 m.) each. Both crossings are of the pure cantilever type, the side openings being the anchor arms, and the middle opening containing a suspended span. The axis of the bridge makes an angle of 75° with that of the river. The upper deck, which carries the tracks of the Metropolitan, is supported by columns which stand on the interior trusses of the lower viaduct. The upper deck is at a uniform level throughout its length, whereas the lower or roadway floor has a steady slope



GENERAL VIEW OF NEW PASSY BRIDGE OVER THE SEINE, METROPOLITAN RAILWAY, PARIS, FRANCE.
View looking toward left bank. The Seine flows from left to right in the picture.

*61 Rue Louis Blanc, Paris, France.

†Engineering News, Feb. 18, 1904, p. 161.

*Engineering News, Dec. 7, 1905, p. 604.

downward of 0.7% from the left bank of the river to the right, as shown in Fig. 1; consequently the height of the upper viaduct above the lower is greater on the right than on the left bank.

The end of the bridge on the right bank is connected with the Quai de Passy station by seven metallic spans placed on the axis of the Rue Alboni. These spans are of unequal lengths, but the longest is only 58 ft.; their principal feature

ble stone set in Portland cement mortar. The granite bridge seats are placed on top of the pier in its longitudinal axis.

The maximum pressure at the base of the piers, on the caissons, is 43 lbs. per sq. in. (3 kg. per sq. cm.), and that on the ground under the caisson is 71 lbs. per sq. in. (5 kg. per sq. cm.).

SUPERSTRUCTURE.—It was impossible, on account of the density of river traffic on both

member between the two web-plates of chords. Fig. 4 shows in detail some typical tions of one of the central (heavy) main t The joints at the ends of the suspended spa also shown in this drawing. All the pin are cast-steel. The pins over the main pier 8 ins. diam. by 30 ins. long. The maximum sure on this pin is 4,000 lbs. per sq. in. proj area.

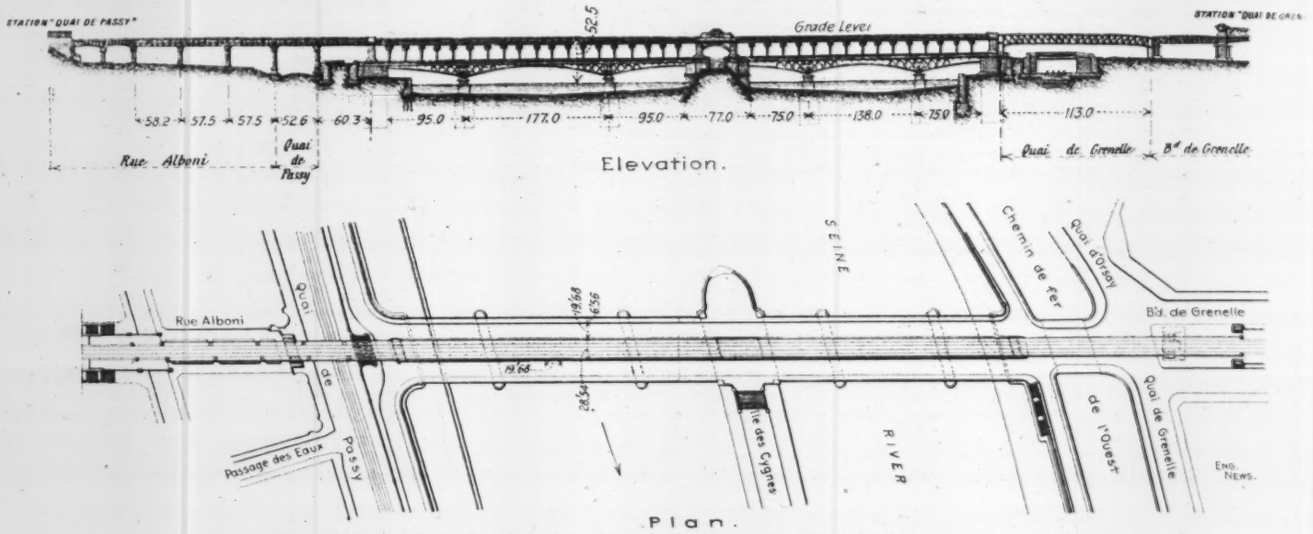


FIG. 1. ELEVATION AND PLAN OF PASSY BRIDGE OVER THE SEINE, METROPOLITAN RY. OF PARIS.
(Dimensions in feet.)

of interest is that they rest on cast-iron columns (see section of these spans in Fig. 1). On the left bank the bridge connects with the Grenelle station by two unequal spans, of which the larger, 181 ft. long, crosses the tracks of the Western Railway. This span is a two-hinged arch, and will be described farther on.

SUBSTRUCTURE.—The abutments at right and left banks are masses of masonry seated on two steel caissons sunk by compressed air to the solid ground, which is found at an average depth of 51 ft. below mean low water in the Seine. The masonry abutment on the Ile des Cygnes rests on piles driven to firm ground. The piers in the river rest also on steel caissons sunk by compressed air to solid ground, encountered at an average depth of 54 ft. below low water.

The masonry piers, shaped as shown in cross-section in Fig. 2, have curvilinear profile below low water, and in this portion are faced

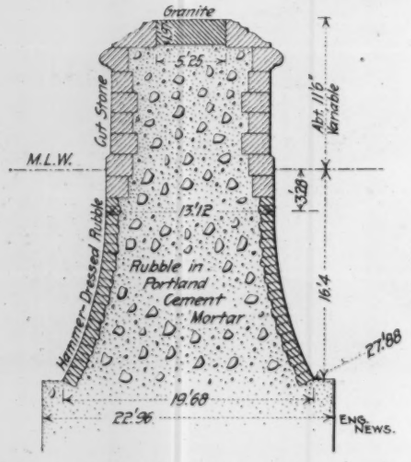


Fig. 2. Cross-Section of River Pier, Passy Bridge.

with roughly dressed stone. About a foot above low water an offset reduces the thickness of the pier to 12½ ft., and the length at the same point, along the transverse axis of the viaduct, is 91 ft. This upper part of the pier is faced with cut stone, bush-hammered, and built in courses 20 ins. high. The inside of the pier is made of rub-

branches of the Seine, to build falseworks for either of the two middle spans. For this reason the cantilever system was adopted. As the diagram, Fig. 3, shows, the type used is the simplest form of pure cantilever bridge, a three-span structure having a suspended span in the central opening.

The longitudinal trusses have a horizontal upper chord and a curved lower chord, so as to give the center span the form of an arch, and of a half arch to the shore spans. The rise of the central pseudo-arch is 12.46 ft. The shore spans are made heavy enough to counterbalance the uplift due to the cantilever arms of the middle span, under the most unfavorable conditions of the live load. The suspended span is connected by a pin-joint at one end, while at the other end it rests on rollers, which arrangement allows for the expansion and contraction of the suspended span. The disposition of fixed and expansion bearings throughout, shown by the diagram Fig. 3, eliminates all temperature stresses.

The main floor of the bridge is 81 ft. wide between hand-rails, and comprises the following: Two sidewalks 6½ ft. wide, along the outside; two roadways 20 ft. wide, just inside of the sidewalks, and a central footway 28 ft. wide, over which runs the elevated structure of the Metropolitan.

There are ten lines of main trusses, of varying spacing, as shown in Fig. 1. The two middle trusses carry the central footway and the elevated structure, as the columns of the latter rest directly on the top chords of these trusses. Three trusses on either side outside of the central trusses carry the roadway. Finally, on the outer line of the sidewalk, there is a false truss, of the same outline as the other main trusses, and having a top and bottom chord and verticals, but no diagonals. The transverse section of the bridge, in Fig. 1, gives the spacing of the trusses.

The chords of the cantilever trusses are of box section, of constant depth 18 ins., with two webs 16 ins. apart. The panel-length, between verticals, is 9.84 ft. A web-plate is used, instead of distinct diagonals, in the shallow end panels of the anchor-arm and of the cantilever arm. The verticals and diagonals are in general of four-angle I-section, with web-plate and where necessary cover-plates, the web being of such width as to allow making end connections by entering the

The suspended span consists of box girders with horizontal top flange and curved bottom flange following the arch outline of the bridge, consequently of variable depth. The two webs of the girder are 16 ins. apart as in the chords of the cantilever trusses.

Floor beams of I-section and I-beam and channel stringers, together with a solid floor, provide lateral stiffness in the plane of the roadway. Crossed diagonals in a vertical plane at each post of the trusses stiffen the lower chord and carry the wind reactions to the piers.

The floor of the roadways consists of buckle-plates, carrying a bed of concrete on which is a wood-block pavement. The sidewalks of the cantilever and suspended spans are floored with flat steel plates, carrying a concrete bed topped off with a wearing surface. In the anchor arms it was necessary to secure additional weight so as to avoid uplift at the abutments, and for this reason the sidewalk floors in the anchor arms are brick arches turned between the stringers.

ELEVATED VIADUCT.—The structure which carries the Metropolitan tracks is composed of a series of steel columns standing on the upper chords of the two middle longitudinal trusses. These columns are 19.7 ft. apart longitudinally, while laterally they are 14.4 ft. apart, this being the center to center distance of the middle trusses. The height of the rail above the roadway of the lower deck is 24.93 ft. at the middle of the main channel and 23.16 ft. at the middle

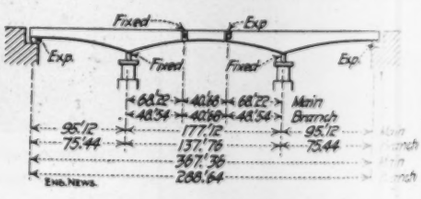


Fig. 3. Diagram of Bridge Over One Bra of River, Showing Type of Structure.

of the branch channel. The track grade is el, as already noted.

The columns of the viaduct are riveted steel members of cross-shaped section. Fig. 5 gives a suggestion of the elaborate manner in which the ordinary form of such riveted columns was modified to produce an ornamental effect.

On each bent of columns rests a transverse plate-girder 22½ ins. deep, constituting a floor beam of the viaduct. Four plate-girder stringers of the same depth, one under each rail, framed into the floor beams, connect them longitudinally. The floor beams cantilever out beyond either column 4 ft. 9 ins.; their ends are connected by a plate-girder fascia, set at such an elevation as to form a continuous parapet, as shown in Fig. 5. The total width of the railway deck between parapets is 24 ft. It is floored with flat steel plates riveted over floor beams and stringers.

An interesting detail of the elevated viaduct was adopted in order to prevent the increase of load on the leeward truss due to the lateral pressure of wind on the viaduct. It was thought that this vertical effect of the wind, affecting only the truss nearest the middle, and giving this truss a greater deflection than the adjacent ones, would result in distortions of the floor, producing a distribution of load other than intended. To prevent this the viaduct floor is caused to transfer its wind load direct to the abutments, and the footings of the viaduct columns are so detailed as to be incapable of transferring lateral forces to the lower deck. If the reactions of the column footings are always vertical, the wind pressure being resisted by the floor of the railway deck, there will be no overturning moment, and hence no increase of vertical load on the leeward truss due to wind. The detail at the foot of the column is a sort of elastic joint, which carries vertical load, but is not well adapted to offer lateral resistance. The anchorage of the railway floor at the abutments consists of cast-steel shoes, on which the stringers rest. The shoes are bolted to a transverse abutment girder 12 ins. deep, which in turn is strongly anchored to the masonry. The top face of each bed-plate has a longitudinal flange on each side, so as to make the stringer rest in a groove. The stringer has thus full freedom of longitudinal expansion, but is held against lateral motion.

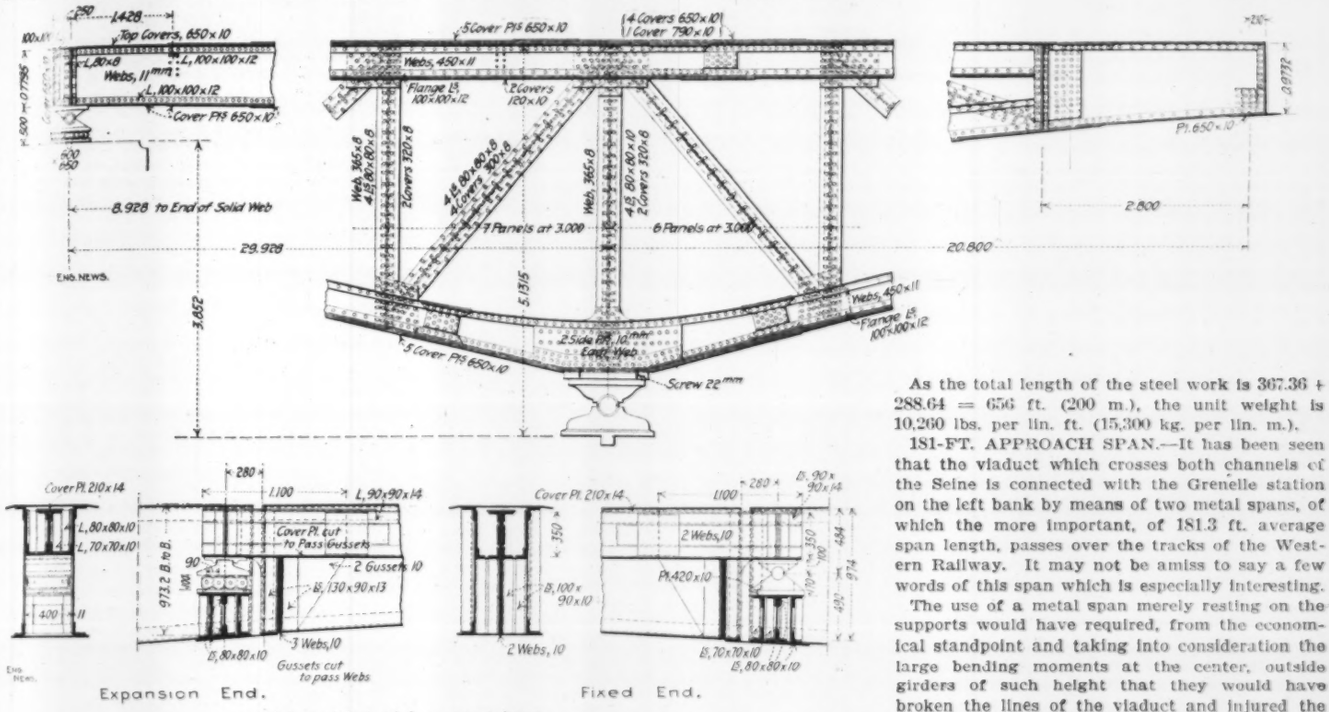


FIG. 4. SOME DETAILS OF THE MAIN TRUSSES, PASSY CANTILEVER BRIDGE.
(Dimensions in meters and millimeters.)

ERECTION.—Because of the cantilever system of trusses adopted, the erection of the metal work was carried on very simply. The shore or anchor arms were first built on falseworks, then the cantilever arms were carried out from the piers progressively without falseworks, and finally the girders forming the suspended span were placed in position as one piece. When the floor of the main deck was placed, the elevated viaduct could be built very easily, a traveling derrick running on the main floor being used.

STRESSES AND WEIGHTS.—All parts of the metal framework of the Passy bridge were designed for a maximum stress (due to dead load, live load and wind pressure) of 14,200 lbs. per sq. in. (10 kg. per sq. mm.). The total weight of the metal work of the bridge is as follows, including the structures over both channels, in tons of 2,000 lbs.:

Trusses and lower deck	2,750 tons
Columns and upper deck	616 tons
	3,366 tons

As the total length of the steel work is 367.36 + 288.64 = 656 ft. (200 m.), the unit weight is 10,260 lbs. per lin. ft. (15,300 kg. per lin. m.).

181-FT. APPROACH SPAN.—It has been seen that the viaduct which crosses both channels of the Seine is connected with the Grenelle station on the left bank by means of two metal spans, of which the more important, of 181.3 ft. average span length, passes over the tracks of the Western Railway. It may not be amiss to say a few words of this span which is especially interesting.

The use of a metal span merely resting on the supports would have required, from the economical standpoint and taking into consideration the large bending moments at the center, outside girders of such height that they would have broken the lines of the viaduct and injured the general appearance of the structure. Resort was had, therefore, to a system of girders used for the first time, it is believed, about 15 years ago for several bridges of the Eastern Railway system of France. This system comprises girder integral with the metal supporting columns, the latter having a hinge support at their lower ends. In a word, it is an arch with two hinges, the neutral axis being vertical from the hinges at the spring of the arch to the level of the top of the arch, and horizontal for the entire width of the span.

This arrangement causes a thrust at the springing line articulations whose moments reduce the bending moments, due to the dead and live loads, of a beam merely resting on its points of support. The total resulting bending moments which the girder must resist are, therefore, greatly lessened. In this way, and with this system, quite wide spans can be crossed under good economic conditions by girders of low height. This arrangement, applied to the Passy viaduct, has allowed the harmony of the main lines to be preserved. Fig. 6 shows the span in elevation, plan and section.

The span is oblique. The width between the end hinges of the up-stream girder is 184.3 ft., and for the down-stream girder it is 178.4 ft., an average of 181.3 ft. The two main girders are 11 ft. deep at the middle of the span; thus the

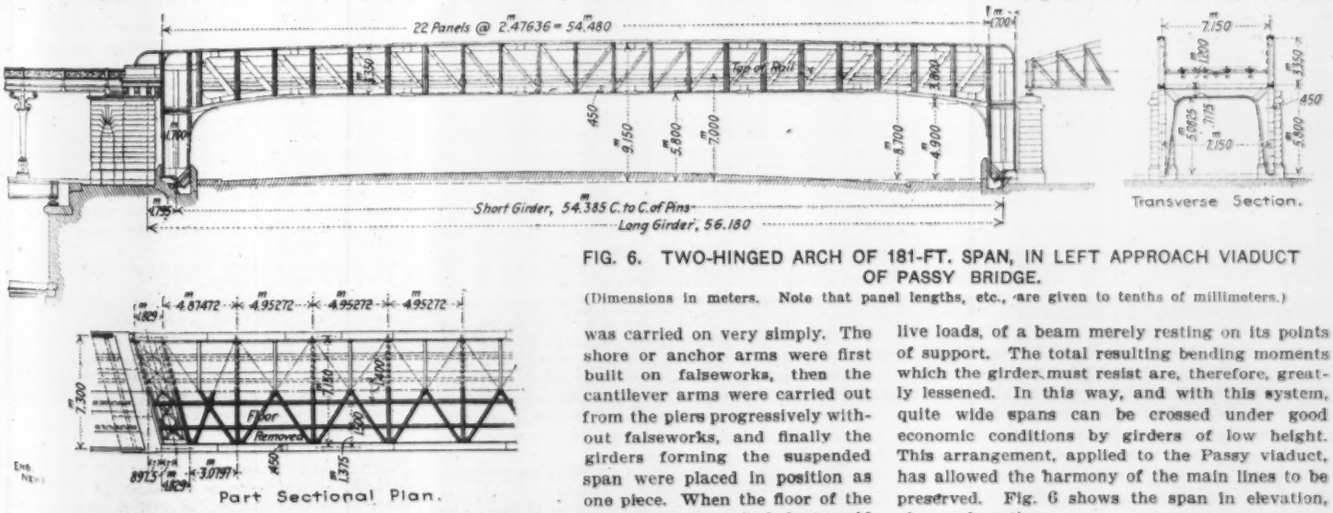


FIG. 6. TWO-HINGED ARCH OF 181-FT. SPAN, IN LEFT APPROACH VIADUCT OF PASSY BRIDGE.
(Dimensions in meters. Note that panel lengths, etc., are given to tenths of millimeters.)

ratio of span to depth is 181.3 ÷ 11 = 16.5, instead of about 8, in the case of an ordinary girder resting on two points of support.

The upper flange of the girders is horizontal, as is also the lower flange, except near the piers where the depth increases, as may be seen in Fig. 6. The flanges are box girders. The web system has a panel length of 8.13 ft. The columns are made with a solid web and are 5 ft. 7 ins. wide

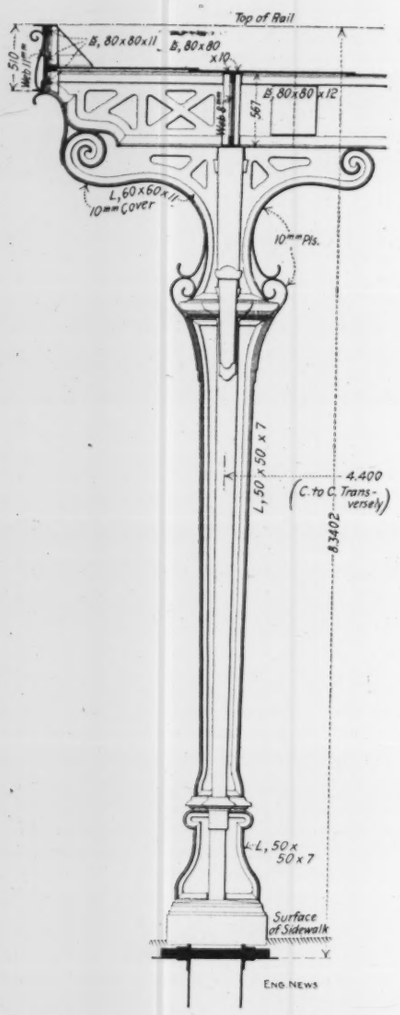


Fig. 5. Part Cross-Section of Elevated Viaduct of Metropolitan Ry., Over Passy Bridge.

parallel to the axis of the track. The two columns at either end are connected together by a solid web portal bracing, which leaves the passage for pedestrians free.

This span, like the river bridge, was designed for a maximum stress of 14,200 lbs. per sq. in. The total weight of the framework is 255 tons, giving a unit weight of 2,810 lbs. per lin. ft. (4,200 kg. per lin. m.).

The metallic part of the Passy viaduct and of the 181-ft. approach span was executed by Messrs. Daydé and Pillé, the authors of the project accepted by the administration as the result of the competition, opened in 1902, among French builders. The work was designed by Mr. Thomas, Division Engineer, under the direction of Mr. Bienvenue, Chief Engineer of the Metropolitan Railway.

LARGER SALARIES and wages will be paid to all permanent employees of the Pennsylvania Railroad System now receiving less than $200 per month. The Board of Directors has ordered a 10% increase of wages, to take effect Dec. 1, which means a total increase of $8,435,424 a year in salaries paid to employees.

STANDARD CONDITIONS AND SPECIFICATIONS FOR TELEPHONE OR OTHER LOW-TENSION WIRES CROSSING RAILWAY TRACKS.*

OVER CROSSINGS.

CONDITIONS.—The telephone company shall, at all times, at its own expense, maintain in good order and condition, and at the height called for by the specifications hereinafter set forth, the lines, wires and cables crossing the said railway so that at no time shall any damage be caused to the company owning, operating or using the said railway or to any person lawfully upon or using the same, and shall use all proper and necessary means to prevent any such wires and cables from sagging below said height.

The telephone company shall, at all times, wholly indemnify the company owning, operating or using the said railway of, from and against all loss, costs, damage and expense to which the said railway company may be put by reason of any damage or injury to person or property caused by any of the said wires or cables, or any works or appliances herein provided for, not being erected in all respects in compliance with the terms and provisions of the order giving leave for the crossing, or if, when so erected, not being at all times maintained and kept in good order and condition and in accordance with the terms and provisions of said order or any order or orders of the board in relation thereto, as well as any damage or injury resulting from the imprudence, neglect or want of skill of any of the employees or agents of the telephone company.

No work shall at any time be done under authority of the order authorizing the crossing in such a manner as to obstruct, delay or in any way interfere with the operation or safety of the trains or traffic on the said railway.

Where, in effecting any such crossing, the telephone company desires to erect poles between the tracks of the railway, before any work in connection with such crossing is begun, the telephone company shall give to the railway company owning, operating or using the said railway, at least 48 hours' prior notice thereof in writing, and the said railway company shall be entitled to appoint an inspector under whose supervision such work shall be done, and whose wages, at a rate not to exceed $3.00 per day, shall be paid by the telephone company.

Where wires or cables to be carried across the railway are to be carried above existing telegraph or other telephone wires and across a trolley wire or other high-voltage wires, either within the spans to be constructed across the railway or within the spans next thereto on either side, such additional precautions shall be taken by the telephone company by the placing of guard wires or other protective devices as the engineer of the board shall consider necessary.

Nothing in the order authorizing the crossing shall prejudice or detract from the right of the company owning, operating or using the railway to adopt at any time the use of electric or other motive power and to place and maintain upon or under its right-of-way such poles, lines, wires, cables, pipes, conduits and other fixtures and appliances as may be necessary, or proper for such purposes. Liability for the cost of any removal, change in location, or construction of the poles, lines, wires, cables or other fixtures or appliances erected by the telephone company under authority of any order of the board over the tracks of the said railway company rendered necessary by any of the matters referred to in this paragraph shall be fixed by the board on the application of any party interested.

Any dispute arising between the telephone company and the said railway as to the manner in which the said wires and cables are being erected, maintained, used or repaired, shall be referred to the chief engineer of the board, whose decision shall be final.

SPECIFICATIONS.—Poles to be located, wherever possible, at a distance from the rail not less than equal to the length of the poles used. They must not, under any circumstances, be placed less than 12 ft. from either rail of a main line, or less than 6 ft. from either rail of siding. At loading sidings sufficient space must be left for a driveway.

Poles of 25 ft. to 34 ft. in length must be set not less than 5 ft.; 35 ft., 5½ ft.; 36 ft. to 50 ft., not less than 6 ft.; and over 50 ft., 7 ft. in solid ground. Poles with side strains must be reinforced. Poles must be at least 6 ins. in diameter at top. In soft ground, poles must be set so as to obtain the same amount of rigidity as would be obtained by the above specifications for setting poles in solid ground.

The span must be as short as possible consistent with the rules of locating and setting of poles.

The pole at each side of a railway must be fitted with double cross-arms of dimensions not less than 3 × 4 ins., equipped with 1¼-in. hardwood pins nailed in arm; arm to be properly fastened to the pole in a gain by not less than two lag screws ½ × 7 ins., or by a ⅝-in. machine bolt through the pole; arms carrying more than two wires or carrying a cable must be braced by iron braces fastened to the arm by ⅝-in. carriage and to the pole by a lag screw 5 × ⅞ ins.

The lowest wire must not be less than 25 ft. from top of rail for spans up to 145 ft.; 2½ ft. additional clearance must be given for every 20 ft. additional length of span. Wires crossing over or under telegraph or telephone wires erected along the railway right-of-way must clear either 3 ft. over or 3 ft. under.

Where open lines are strung across railway tracks the stretch must consist of copper wire, to be of not less than No. 13, New British Standard Gage, 0.091 in. in diameter. Wire must be tied to the insulator on each of the double cross-arms by a soft copper tie-wire, of same dimensions as line wire, not less than 20 ins. in length.

Where a number of rubber-covered wires are strung across railway tracks they may be made up into a cable by being twisted on each other or sewn with marline, which must be tied every 3 ft., and the whole securely fastened to the poles by marline. Guy wires crossing railway tracks must consist of either 7 stranded, No. 16, or No. 13, galvanized steel wire, and must be clearly indicated as guy wires on the plan accompanying the application.

An iron hook guard must be placed on the end of each cross arm, or a copper wire loop-guard over each wire, and fastened by staples to the cross-arm.

Where cables are strung across tracks they must be carried on a suspension wire of not less than 7 strands of No. 16, galvanized steel wire, which, when cross-arms are used, will be attached to a ¾-in. iron hook, or when fastened to poles, a malleable iron messenger hanger bolted through the poles. The cable must be attached to the suspension wire by cable clips not more than 20 ins. apart.

Rubber insulated cables of less than ¾-in. in diameter may be carried on a suspension wire of not less than 7 strands of No. 16, galvanized steel wire.

UNDER CROSSINGS.

CONDITIONS.—The line or lines, wire or wires, shall be carried across the railway in accordance with the approved plan, in a pipe or pipes, conduit or conduits, and each shall, for the whole width of the right-of-way adjoining the highway, be laid at the depth called for by, and shall be constructed, maintained, renewed and repaired according to, the specifications hereinafter set forth.

All work in connection with the laying, maintaining, renewing or repairing of each pipe or conduit, and the continued supervision of the same, shall be performed by, and all cost and expense thereby incurred be borne and paid by, the telephone company, but no work shall at any time be done under authority of the order in such a manner as to obstruct, delay, or in any way interfere with the operation or safety of the trains or traffic on the said railway.

The telephone company shall, at all times, maintain each pipe or conduit in good order and condition, and so that at no time shall any damage be caused to the property of the railway company, or any of its tracks be obstructed, or the usefulness or safety of the same for railway purposes be impaired, or the full use or enjoyment thereof by the said railway company be in any way interfered with.

Before any work of laying, renewing or repairing any pipe or conduit is begun, the telephone company shall give to the railway company at least 48 hours' prior notice thereof, in writing, accompanied by a plan and profile of the part of the railway to be affected, showing the proposed location of such pipe or conduit and works contemplated in connection therewith. The said railway company shall be entitled to appoint an inspector to see that the telephone company, in performing said work, complies, in all respects, with the terms and conditions of the order authorizing the work, and whose wages, at a rate not exceeding $3.00 per day, shall be paid by the telephone company.

The telephone company shall, at all times, wholly indemnify the company owning, operating or using the said railway of, from and against all loss, costs, damage and expense to which the said railway company may be put by reason of any damage or injury to person or property caused by any pipe or conduit, or any works or appliances therein, or in the order authorizing the work provided for not being laid and constructed in all respects in compliance with the terms and provisions of the order authorizing the work, or if, when so constructed and laid, not being at all times maintained and kept in good order and condition and in accordance with the terms and provisions of said order, or any order, or orders of the board in relation thereto, as well as any damage or injury resulting from the imprudence, neglect or want of skill of any of the employees or agents of the telephone company.

Nothing in this order shall prejudice or detract from the right of any company owning or operating or using the said railway to adopt, at any time, the use of electric or other motive power, and to place and maintain upon

*In use by the Bell Telephone Co., of Canada, and given by Mr. E. E. Parsons in a paper read at the Denver meeting of the Association of Railway Telegraph Superintendents.

or under the said right-of-way such poles, wires, pipes and other fixtures and appliances as may be necessary or proper for such purposes.

Liability for the cost of any removal, change in location, or reconstruction of the pipes, conduits, wires or cables constructed or laid by the telephone company under authority of an order of the board, rendered necessary by any of the matters referred to in this paragraph, shall be fixed by the board on the application of any party interested.

Any dispute arising between the telephone company and any company owning, using or operating said railway as to the manner in which any pipe or conduit, or any works or appliances hereinbefore provided for, are being laid, maintained, renewed or repaired, shall be referred to the chief engineer of the board, whose decision shall be final.

SPECIFICATIONS.—Vitrified clay, cement pipe, creosoted wood, iron pipe, or fiber, may be used for the duct. The excavation must be of sufficient depth to allow the top duct to be at least 3 ft. below the bottom of the ties of the railway tracks.

The duct must be laid on a base of 3 ins. of concrete mixed in proportion, one of Portland cement, three of sand, and five of broken stone or gravel. Where stone is used such stone must not be of greater size than will permit of its passage through a 1-in. ring.

After ducts are laid, the whole must be encased to a thickness of 3 ins. on top and sides in concrete mixed in the same proportions as above.

The excavation must be filled in slowly and well tamped on top and sides, and must at all times be safely protected.

TEST OF THE BRITISH TORPEDO BOAT DESTROYER "GADFLY."

On September 27, 1906, a very successful full-speed official trial was carried out with H. M. S. "Gadfly," the first of the new class of torpedo boat destroyers for the British Navy.

The vessel is fitted with steam turbines and water tube boilers, the latter being fired with oil fuel. She is 168 ft. long by 17½-ft. beam, with a maximum draft of about 6½ ft.

The turbines are arranged to drive three shafts, half the power being on the central shaft and one-quarter on each of the wing shafts. The low pressure and astern turbines are on the center shaft, and to it are also connected the cruising turbines for low speed.

The vessel was practically complete for handing over to the Admiralty, including armament, and her load of 24 tons, representing stores, ammunition, etc., and carried sufficient oil, with some margin, for the 8-hour trial at the contract full speed of 26 knots.

The mean speed obtained during the 8 hours' trial was 27.336 knots, the speed being estimated in the usual way from six runs on the measured mile, taken during the fifth hour of the trial. The mean speed for the six runs was 27.505 knots.

The oil consumed during the trial was 22.6 tons, which corresponds to about 1½ lbs. per HP.-hr. There was practically no smoke.

On the following day a series of steering and circle-turning trials were successfully carried out. She was afterwards run for ¼ hour with the center shaft revolving at 700 revolutions, giving a speed of approximately 13 knots.

The illustrations shown herewith were taken during these latter trials. The vessel was built by Messrs. John I. Thornycroft & Co., Ltd., at their Chiswick Works. She is fitted with Parsons turbines, "Thornycroft" boilers, and the British Admiralty oil fuel apparatus.

We are indebted to the builders for the illustrations and information given.

TESTS OF OTHER WOODS THAN PINE FOR PAVING PURPOSES.

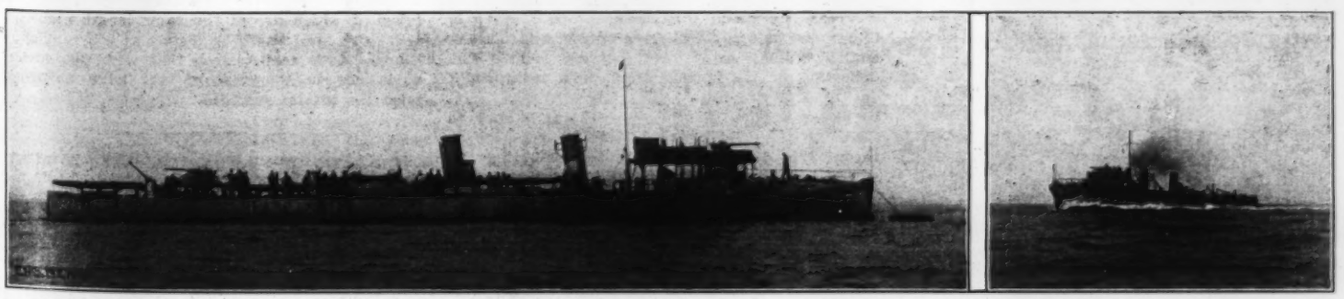
The effect of the increase in the price of long-leaf yellow pine on wood pavement was noted in our issue of Aug. 16, in the course of an abstract of a paper entitled "Recent Developments in Wood Block Paving" by Mr. F. A. Kummer,* M. Am. Soc. C. E. At the recent meeting of the American Society of Municipal Improvements at Birmingham, Ala., Mr. Kummer discussed this subject at more length. He stated that five or six years ago "all heart, long-leaf, Georgia pine" was bought by him at less than $20 per 1,000 delivered in New York, while to-day inferior grades of the same kind of lumber cost about $30. The difference of $10 per 1,000 ft. adds 36 cts. per sq. yd. to the cost of 4-in. wood block pavement. As this pavement, Mr. Kummer states, was in point of first cost the most expensive on the market, the large increase in cost has limited the demand for that character of pavement to some extent. Accordingly attention has been turned to other kinds of wood, both by private interests and by the Bureau of Forestry of the U. S. Department of Agriculture. Joint tests of other woods are to be made at Minneapolis by the Bureau of Forestry, the City of Minneapolis, and the Kettle River Quarries Co. of Minneapolis, the latter being manufacturers of wood block. Among the woods that will be laid for test purposes on a heavily traveled street are Norway pine and tamarack. The Bureau of Forestry has also arranged with the U. S. Wood Preserving Co. and the City of New York to make comparative tests in the latter city of long-leaf yellow pine, short-leaf pine, tupelo, loblolly pine, maple, sap gum, scrub pine and scrub oak. Mr. Kummer states in his paper that he has doubts as to the practicability of scrub oak, maple and some of the other woods just named, as it is questionable whether they can be obtained in sufficient quantities and at low enough prices to warrant their use for paving purposes.

As mentioned in our previous article, the company with which Mr. Kummer is connected has recently been laying considerable quantities of black gum. This wood, which the company is now obtaining at Norfolk, Va., was laid between surface railway tracks on Hudson St., New York, about a year ago, and, Mr. Kummer states, has given good results. The space between the street railway tracks on Lexington Ave., New York City, between 42d and 72d Sts., has also been paved with black gum. His company has recently contracted to lay about 60,000 sq. yds. of black gum pavement in the Borough of the Bronx and has made large shipments of the wood to Boston, Holyoke and Springfield, Mass., and to Bridgeport, Conn.

Besides the fact that black gum is now "materially cheaper than pine and promises to remain so," it wastes less than pine in cutting, handling and shipping. As a disadvantage, the black gum is heavier than yellow pine, thus costing more for freight; and it takes longer to drive off its contained moisture for treatment, and a greater amount of preservative per cubic foot of wood, than is the case with yellow pine. Further statements made by Mr. Kummer in the course of his paper are given in his own language, as follows:

In any determination as to the value of a wood for paving purposes, if we start with the assumption that by filling the pores of the wood throughout the block completely with a good quality of creosote oil decay can be prevented, there remains only one other question to be decided and that is whether the wood is sufficiently dense, tough and hard to successfully resist heavy travel. Such a determination is not a very difficult matter. In fact, it is almost self-evident that using Georgia pine as a standard, any block which is as hard or harder than this wood should give equally as good or better results, while those blocks which are not so hard—such, for instance, as short leaf, loblolly and Norway pine—should give less satisfactory results. The writer believes that all these woods can be used for paving purposes if properly treated, but should be used with discrimination. A street laid with loblolly pine under moderate travel might readily give a serviceable life of twenty years or more, while a similar pavement under the excessively heavy travel found on such streets as exist in the lower part of New York City would probably be destroyed very quickly. The length of life of a wood block pavement is not directly proportional to the travel. Take, for instance, two streets laid with the same wood, in the same manner. If the traffic on one street approaches but does not reach the limit of durability of the wood, the pavement will last almost indefinitely because the character of the traffic is not sufficiently heavy to destroy it; but if the traffic in its character as well as amount passes the limit of durability of the wood employed, the pavement will be destroyed in a comparatively short time. It would seem that for each class of timber there is a condition of traffic beyond which it should not be subjected, but no determination of these limits could correctly be made except from a great number of actual service tests. In a general way, however, satisfactory results may be obtained by dividing the streets into three classes: heavy, medium and light travel. On the third class of streets practically any wood which would not decay would give an indefinite life. On the second class discrimination should be used, although woods as soft as Norway pine have given excellent results under these conditions. On the first class of streets it would probably be dangerous to lay any wood less durable and resisting than the best quality of long-leaf pine. So far the writer does not know of any available wood other than the black gum before mentioned which could be safely included with long-leaf pine in this category. By this, of course, is meant woods which can be obtained in large quantities commercially, and which possess the element of toughness rather than that of extreme hardness.

The douglas fir, or Oregon pine of the northwest, is almost an ideal material for general paving block purposes. It is not quite so hard or tough as long-leaf yellow pine or black gum, and for this reason will probably be excluded from streets of the most extreme travel; but with the exception of perhaps a very few streets of this char-



THE BRITISH TORPEDO BOAT DESTROYER "GADFLY" AS SHE APPEARS WHEN AT ANCHOR AND WHEN TRAVELING AT FULL SPEED.

Tests were also made of the capabilities for stopping, starting, and going astern, and these were found to be practically the same as with an ordinary single-screw torpedo boat.

The vessel was steamed astern for ¼ hour with the center propeller revolving at two-thirds the speed required for 26 knots. A run over the measured mile showed a speed of about 12 knots.

*Chief Engineer, U. S. Wood Preserving Co., 29 Broadway, New York City.

acter it would prove equally satisfactory, and possess the great advantage of being extremely regular and homogeneous in texture so that the differences between hard and soft wood found in the smaller long-leaf yellow pine trees would not exist and pavements could be laid which would wear with perfect regularity throughout their entire surface. There is no opportunity to secure this wood for paving purposes east of the Mississippi River at the present time, but with the completion of the

Panama Canal it will no doubt become a very extensively used wood for all purposes in the eastern part of the United States.

So far as our experience has gone it seems true that the best woods for paving block purposes are those which are dense and homogeneous—with little, if any, difference between the durability of different parts of the block, tough rather than hard, and capable of treatment without danger of warping or splitting.

In addition, from a commercial standpoint, it should be necessary that such woods are obtainable in large quantities at reasonable prices. At this time it is safe to name four, in the order named: long-leaf yellow pine, black gum, Oregon pine, Norway pine. Beyond these it is not certain what the results may be, although short-leaf pine and tamarack have both been used in limited quantities, and the writer sees no reason why they should not be successfully employed if used on suitable streets.

INSTRUMENTS FOR MEASURING THE SECONDARY MOVEMENTS OF VEHICLES IN MOTION.*

By M. Sabouret.†

The secondary movements of vehicles in motion differ from the movements of solidly fastened parts of a mechanism in that the latter may be deduced geometrically according to the manner in which they are guided, whereas the former are relatively irregular and require special apparatus for studying them.

Common examples of secondary movements are: the variations in the deflection of a spring; the two movements in a horizontal plane of an axle free with respect to the frame; the two movements, as compared to the frame of the loose cross-bar of a truck; the oscillations of a compensating pendulum, of a suspended part, a buffer, of a coupling-bar; the displacement of an axle journal in its box; the relative displacements of two connected buffers.

APPARATUS FOR RECORDING SECONDARY MOVEMENTS.

The apparatus consists essentially of the three following parts: the "explorers," which are installed on the different parts producing the secondary movements; the "transmitters," which connect the explorers with the "recorder"; and the recorder which inscribes on a chart the indications sent in by the different explorers, with respect to the part of the road where they are produced and to the speed of the train.

The explorers are of two kinds—linear and ballistic. Linear explorers are used to observe linear oscillation or the variation in the distance between two points. Ballistic explorers are used to measure the speed of the mass in motion during transverse or vertical shocks such as those caused by the bumping of the vehicle against the rails.

The mode of transmission is shown in Fig. 1. There are two small brass drums A and A^1, the former the exploring drum and the latter the recording drum, each closed by a rubber membrane and connected to the other by a tube. Any displacement of the center a of the exploring drum produces a proportional displacement of the center a^1 of the recording drum. The movement of a^1 amplified by the lever a^1 o P, is inscribed in ink by the pen P on a chart F which passes uniformly before it.

The sensitiveness of this method depends upon the diameters of the drums and upon the lengths of the arms of the lever employed on the explorer and on the recorder. If the secondary movements are very rapid, the inertia of the air, the membranes, and the levers, as well as the friction of the air in the tube, deprive the method of its sensitiveness and precision. With very slow secondary movements, the variations in temperature cause an appreciable error, which, however, may be obviated in a manner described later.

The secondary movements of rail motor cars in motion are never allowed to become very rapid on account of the importance of the masses involved, and as they are never less than 1/8 sec. in duration, the method described gives excellent results in this case even when the movements are transmitted over 60 ft.

FIG. 1. SIMPLE ARRANGEMENT OF APPARATUS FOR RECORDING SECONDARY MOVEMENTS.

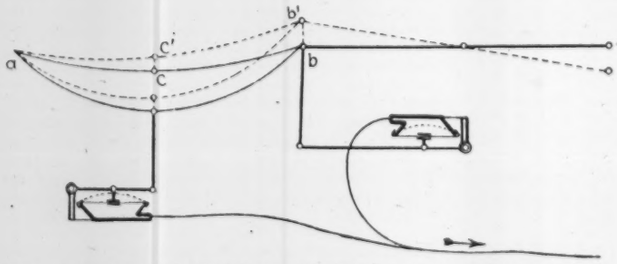


FIG. 3. A CASE IN WHICH THE METHOD ILLUSTRATED IN FIG. 2 WOULD BE USED.

RECORDING COMBINED SECONDARY MOVEMENTS.

Referring to Fig. 2, A and B represent two exploring drums placed at different points, a and b. If the tubes from A and B be united in one tube terminating at the recording drum E, the recorder will give the algebraic sum of the displacements of the points a and b.

A case in which this method would apply is illustrated in Fig. 3, where a spring a b has one end b bearing on a compensating lever. The deflection of the spring which is a measure of its stress is equal to $c\,c^1 - \frac{b\,b^1}{2}$. It is easy to record this deflection directly by combining the action of two explorers, one at c which measures $c\,c^1$, and one at b which measures $-\frac{b\,b^1}{2}$. The drum of the explorer at b should be [illegible] the opposite manner to that of the explo[illegible] at c, and the indications reduced one-half by [illegible]perly proportioning the arms of the lever. A[illegible]mple and accurate means is also provided [illegible] the method described, for recording the a[illegible]ment in time of two close secondary movemen[illegible]

RECORDING DIVIDED SECONDA[illegible] MOVEMENTS.

If the tube from a single exploring d[illegible] A, Fig. 4, be divided and attached to two [illegible]ord-ing drums E^1 E^2, a double curve of an o[illegible]rved movement will be obtained which is often [illegible] ad-vantage. If the chart moves slowly, o[illegible] the amplitude and the frequency of the o[illegible]rved movement are given. When it is desired t[illegible]study besides these, the form of the oscillatio[illegible] the chart must move much more rapidly bef[illegible] the pen. In the divided recorder, Fig. 4, th[illegible]drum E^1 serves to trace continuously on a slow[illegible] moving chart, and the drum E^2 which is mor[illegible] sen-sitive and provided with a stylus, traces [illegible]ring a few seconds a detailed curve on a [illegible]pidly moving smoked-paper chart.

COMPENSATION FOR TEMPERATU[illegible]

The air enclosed by the exploring and recording drums and the connecting tubes is very sensitive to variations in temperature. In general, however, the temperature variations are very slow in comparison with the secondary movements studied, and all that is necessary is to bring the pen back to zero occasionally by placing the tube in communication with the atmosphere.

For very accurate testing the error introduced by variations in temperature should be eliminated by adopting the differential arrangement shown in Fig. 5. Here the oscillating point a acts on two connected exploring drums, the tubes of which are of the same length and connect with two recording drums at e arranged as shown. It is readily seen that with this device, variations in temperature will have no effect upon the results recorded.

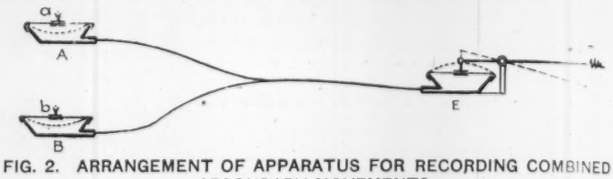


FIG. 2. ARRANGEMENT OF APPARATUS FOR RECORDING COMBINED SECONDARY MOVEMENTS.

FIG. 4. ARRANGEMENT OF APPARATUS FOR RECORDING DIVIDED SECONDARY MOVEMENTS.

FIG. 5. A DIFFERENTIAL ARRANGEMENT OF THE APPARATUS FOR ELIMINATING TEMPERATURE ERRORS.

THE RATIO OF FINISHED CONCRETE TO LOOSE materials used for the piers at Fairport and Lorain harbors, Ohio, built by the U. S. A., is given in the Chief of Engineer's report for the year ending June 30, 1904, as follows:

	Fairport Harbor		Lorain Harbor	
	Concrete blocks	Concrete in mass	Concrete blocks	Concrete in mass
Cement	Lehigh Portland 209 cu. yds. (1,413 bbls.)	Lehigh Portland 555 cu. yds. (3,743 bbls.)	Sandusky Portland 385 cu. yds. (2,600 bbls.)	Sandusky Portland 900 cu. yds. (6,150 bbls.)
Beach sand	418 cu. yds.	1,110 cu. yds.	770 cu. yds.	1,800 cu. yds.
Gravel	418 "	960 "	1,155 "	2,490 "
Broken lime stone	836 "	1,920 "	1,540 "	3,320 "
Total volume of materials	1,881 "	4,545 "	3,850 "	8,510 "
Total volume of concrete	1,297 "	2,936 "	2,575 "	5,580 "
Ratio of concrete to materials	69%	64.6%	66.9%	65.5%
Bbls. of cement per cu. yd.	1.08	1.27	1.01	1.10
Proportions of concrete	1 cement; 2 sand; 3 gravel; 4 unscreened broken stone.		1 cement; 2 sand; 3 gravel; 4 screened broken stone.	
Contract price of concrete blocks	$11.37 and $11.25 per cu. yd.		$9.95 per cu. yd.	
Contract price of concrete mass	$7.50 per cu. yd.		$7.80 per cu. yd.	

*Translated from the French by Ernest H. Du Vivier, 14 Church St., New York, American representative of the apparatus described.

†Engineer of Traction, Western Railway of France.

A LARGE WATER TANK WITH VERTICAL BRACING AND TOP STIFFENING RING.

An unusually large water tank was completed at Rochester, N. Y., in April, 1905. The tank is of wrought iron, 150 × 20 ft., inside dimensions, and has a capacity of 2,650,000 gals. It is strengthened against internal pressures by 24

FIG. 1. VIEW OF 150 x 20-FT. (2,650,000 GAL.) WROUGHT IRON WATER TANK FOR THE ROCHESTER & LAKE ONTARIO WATER CO., AT ROCHESTER, N. Y.

vertical braces and its top is stiffened by a lattice girder ring, both as shown by the view and the detailed drawings, Figs. 1 and 2. Such construction, though common in gasholder work, has never been used before in water-works, so far as we know. The engineers and contractors for the tank were the American Pipe Manufacturing Co., 112 North Broad St., Philadelphia (Mr. J. W. Ledoux, M. Am. Soc. C. E., Chief Engineer). The iron work was furnished by Tippett & Wood, of Phillipsburg, N. J.

The Rochester & Lake Ontario Water Co., for whom the tank was built, supplies the section immediately west of the city of Rochester, known as Lincoln Park; the towns of Greece and Gates and the village of Brighton, now a portion of the city of Rochester; the villages of Dispatch and Pittsford and a portion of the town of Irondequoit. Some of the largest consumers of the company are the Buffalo, Rochester & Pittsburg R. R., New York Central R. R., Eastman Kodak Co., and the American Fruit Products Co.

The water supply of this system is taken from Lake Ontario (Elev. 247 above Sandy Hook) at a point about 1½ miles west of Charlotte. The water is pumped by high-duty Corliss type pumping engines through mechanical filters and a 24-in. main to the tank, a distance of about 15 miles. The supply then is carried eastward along the New York Central right-of-way to Fairport, a distance of 6 miles. The static head pumped against is 413 ft.

A metal tank rather than a masonry or earth reservoir was built because of unfavorable topography and soil (sandy) for a reservoir.

The ⅜-in. bottom plates of the tank rest on 12 ins. of "grouted" stonework, and the latter rests, in turn, on either the natural earth or else on compacted earth borrowed from the excavation and used to bring the site to grade. The shell of the tank is supported by a rubble masonry wall 6 ft. deep, which extends 9 ins. beyond the shell. The 24 concrete piers that support the vertical braces are 4 ft. sq. on top battering to 6 ft. sq. at a depth of 6 ft. A 1¾-in. anchor bolt connects the iron work above with a 7-in. channel, 2½ ft. long, embedded in the bottom of each pier.

The vertical and horizontal bracing are shown in sufficient detail by Fig. 2, except that the lacing of the ring is composed of 1¾ × ¼-in. bars.

The specifications for the tank called for wrought iron of 48,000 to 50,000 lbs. tensile strength; an elastic limit not less than half the tensile strength; elongation not less than 12% and reduction of area not less than 20% in test pieces 8 ins. long. Specimens from the plates were required to stand cold bending at 90 degrees and to a curve whose diameter is not over six times the thickness of the plate, without cracking. Either wrought iron or steel rivets were permitted.

The five rings of the shell were, successively, ¾, 9/16, 7/16, and ⅜-in. thick. The vertical joints in the two bottom rings of the shell were to be triple riveted, with double butt straps, and the two upper courses, double lap riveted. All the horizontal seams were to be single riveted. The specifications called for three coats of Smith's durable metal coating or Dixon's graphite paint or other "paint of approved quality."

The contractors guaranteed the tank "to be free from defects due to faulty work, material or design for a period of one year after completion."

We are indebted to Mr. Ledoux for the material used in the preparation of both the text and illustrations of this article.

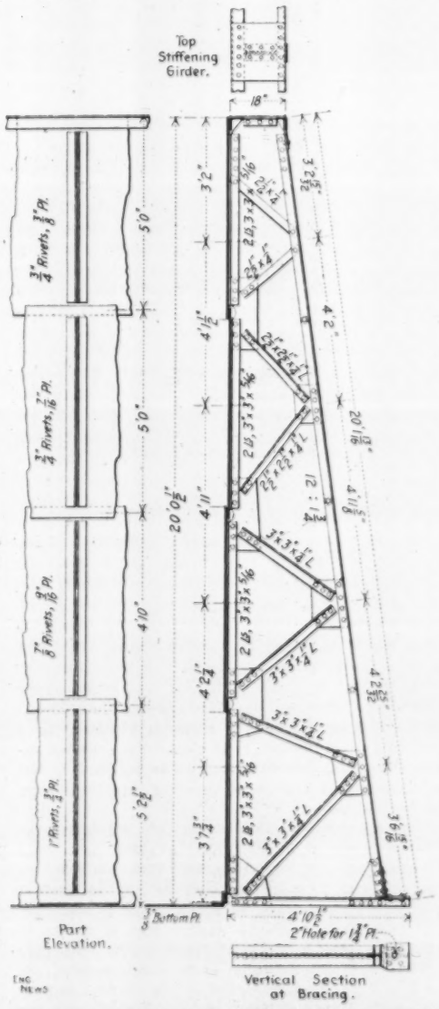


Fig. 2. Details of Vertical Bracing and Top Stiffening Girder for 150 x 20-Ft. Water Tank for Rochester & Lake Ontario Water Tank.

THE RAILWAY GAGE QUESTION IN AUSTRALIA, INDIA AND SOUTH AFRICA.

The desirability, and eventual necessity, of a uniform gage for the railway systems of the several Australian colonies have again come up for discussion, and doubtless will prove a difficult and costly problem. In India, the government is considering whether to double-track its meter-gage main lines as traffic requires greater capacity, or to widen this gage to the Indian standard gage of 5 ft. 6 ins. In South Africa, also, some future trouble of this kind is foreseen. From a recent article in "The Engineer," of London, dealing with this subject, we take the following particulars.

In Australia the troubles have been due largely to railway promoters and projectors, rather than to engineers. The first railway (with the exception of a line at the Melbourne docks) was commenced at Sydney, New South Wales, in 1850, and Mr. F. Wentworth Shields, the engineer, strongly recommended the Irish standard gage of 5 ft. 3 ins. His successor, Mr. James Wallace, favored the English standard gage of 4 ft. 8½ ins., and this was adopted by the New South Wales government by an act of Parliament in 1853. The narrower gage of 3 ft. 6 ins. was adopted by Queensland and some of the other colonies, as it seemed at that time to promise some economy in construction in rough country, with an advantage in saving in dead load of rolling stock; these claims for advantages, however, have long since been disproved. When Queensland built a coast line to connect with the New South Wales system the engineer strongly advocated the adoption of the standard gage of the latter (4 ft. 8½ ins.) so as to provide for intercommunication, but his advice was not followed, and there was consequently a break of gage at the frontier. Both Victoria and South Australia adopted the Irish gage of 5 ft. 3 ins., but in 1870 the latter began to use a gage of 3 ft. 6 ins. for some of its secondary lines, while Victoria adopted a gage of 2 ft. 6 ins. for similar lines. The colony of Western Australia has an isolated system with a gage of 3 ft. 6 ins. Of the other colonies, New South Wales has 4 ft. 8½ ins. (3,280 miles); Victoria, 5 ft. 3 ins. (3,311 miles) and 2 ft. 6 ins. (82 miles); Queensland, 3 ft. 6 ins. (3,092 miles); South Australia, 5 ft. 3 ins. (503 miles), and 3 ft. 6 ins. (1,238 miles).

The proposed new line to connect the older and more settled colonies with the newer colony of Western Australia, making a transcontinental line, has brought up the question of gage very forcibly. This line will be about 1,100 miles long, costing about $25,000,000, and the gage of 4 ft. 8½ ins. was recommended by a conference of the government railway engineers of New South Wales, Victoria, South Australia, Queensland and Western Australia. This same subject, but in regard to the railways of the older colonies, was discussed a few years ago when the federation of the Australian colonies was accomplished, and a report made by a conference of the several railway commissioners in 1897, estimated $12,000,000 as the cost of converting all the lines in Victoria and the broad gage lines of South Australia to the 4 ft. 8½ ins. gage of New South Wales. About $50,000,000 would be required for a similar change in Queensland, and $20,000,000 in addition for changing the narrow gage lines of South Australia, making a total of $82,000,000 for effecting uniformity of gage in the eastern colonies.

As already noted, the government of India, through its railway board, has been investigating

the alternative plans of duplicating or converting its meter-gage lines. The latter plan is said to be the least costly and to involve an expenditure of about $170,000,000. The article from which we take our information states as follows:

The idea so prevalent among politicians 35 years ago, but so incorrect, that lightness and cheapness could not be obtained without reducing the width between the rails, seized the authorities of India, and Lord Mayo, the viceroy, told the newly-arrived consulting engineer to the government, Sir Guildford Molesworth, who had a different opinion, that the question already settled to break the gage could not be reopened.

In South Africa there is as yet no serious diversity, the exceptions to the 3 ft. 6 ins. gage being comparatively insignificant. The English standard gage of 4 ft. 8½ ins. was originally adopted, and several miles were built near Cape Town. This was torn up, however, contrary to the advice of the consulting engineer to the government, Sir Charles H. Gregory. The 3 ft. 6 ins. gage is used in Cape Colony and British Central Africa, Natal, Soudan, Upper Egypt, Lagos, and the Gold Coast; the meter-gage is used in Uganda, Abyssinia, German East Africa, French Soudan, Tunis, Algeria, Senegal and French West Africa. In Sierra Leone the gage is 2 ft. 6 ins., while in the Congo Free State it is 2 ft. 3½ ins., although it was evident from the beginning that this would eventually form part of an east and west transcontinental line.

In regard to the limitations of the gage of 3 ft. 6 ins., the article in question remarks as follows:

Africa promises to be an important cotton-producing country, and owing to its low specific gravity, cotton, even when pressed, occupies so much space that only about half the weight-carrying capacity of the narrow gage car is achieved, the dead-load economy increasing with the gage. This seems a matter of detail, but when it is considered that if cotton is to be burdened with thousands of miles of rail carriage, it will be seen that every pound of useless dead weight carried practically limits the distance from the seaboard at which cotton (as well as other light products of export) can be profitably grown.

A NEW ELECTRIC BLUE-PRINT MACHINE.

This machine, a general view of which is shown in Fig. 1, makes it possible to produce prints, up to 5 ft. in width and of any length up to the full length of a roll of blue-print paper; or a tracing can be repeatedly sent through the machine, thereby making it possible to print continuously without stopping the machine. If small size drawings are used the paper can be cut to size, beforehand, and tracing and paper feed into the

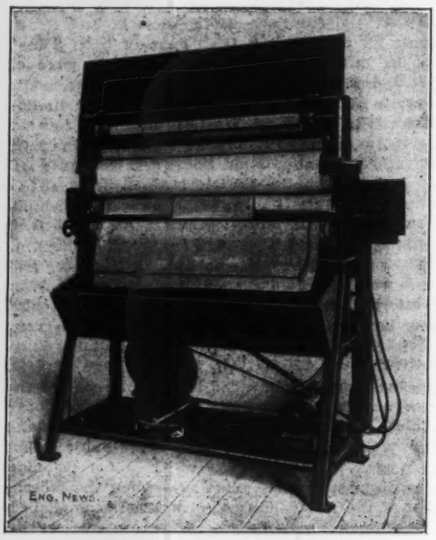


Fig. 1. General View of the Everett-McAdam Blue-Print Machine.
Revolute Machine Co., New York, Makers.

machine together. Neither paper nor time need be wasted when using this machine, as one tracing can immediately follow another, and the machine need not be stopped to insert new material. The tracing and paper go in and out on the same side of the machine, as shown in Fig. 2, thereby making attendance easy.

The machine consists of a cast-iron frame, which supports four wooden rollers, electric motor, electric lamps, etc. (Figs. 1 and 2.) The wooden rollers are ground with a crown to receive 1½-in. endless web belts, side by side the full length of the glass cylinder, which is either 60 to 48 ins. in length, according to size of machine. As shown by Fig. 2, this glass cylinder simply rests in these web belts, being rotated

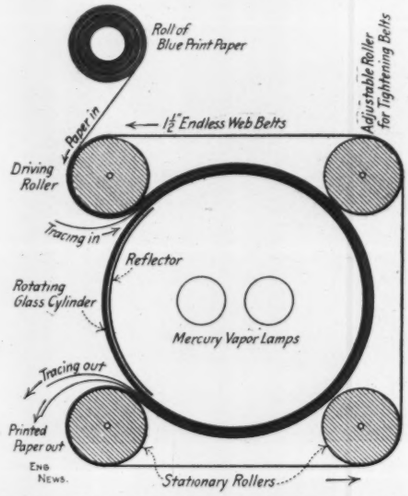


Fig. 2. Sketch Showing General Arrangement of the Everett-McAdam Blue-Print Machine.

thereby. Supported at the ends by the cast-iron end frames and passing through the center of the glass cylinder are two special Cooper Hewitt vacuum tubes, which are used as a light source, instead of the arc lamp usually found in blue-print machines. A reflector, supported by the end frames, is placed at the front of the machine to concentrate the light rays on the paper after it is in the machine, and, at the same time, protect the paper when it is entering the rolls.

The machine is driven by a 1-6-H.P. electric motor, the motor being belted to a worm that engages a gear on the upper front wooden roller. The motor is provided with a friction speed regulator, so that the speed of the machine can be altered by simply moving a small lever. The machine can be instantly thrown out of gear by pressing a button, with the foot, which disengages the worm and gear mentioned above. The upper back wooden roller is adjustable in order that the web belts may be kept tight. The other three rollers are stationary. In order that the interior of the glass cylinder may not become overheated, the motor also drives a small blower which circulates a current of air through the cylinder.

A wooden box is placed on top of the machine to receive the blue-print paper. This box is provided with two spindles, having adjustable cones, so that any length roll of blue-print paper or tracing may be supported therein. Below the cylinder is placed another box to catch the paper and tracing as they come from the machine. The whole machine is very compact, requiring a floor space of only about 2 × 6 ft., while the total height is about 5 ft. for the larger sized machine. Although the price (42-in., $500; 54-in., $700) of this machine is somewhat higher than others on the market, it is claimed by the manufacturers that this higher price is justified by the great economy and great speed of printing effected by its use.

The advantages claimed for this machine over other types of continuous printers are: (1) Greater economy in operation, this machine requiring only 15 amperes to operate it, as against 35 amperes for other machines, while it will turn out ten times as many square feet of prints in the same length of time; (2) it is the only machine that can actually print continuously; (3) absolutely clear prints, due to the narrow endless web belts giving uniform contact between tracing and paper; (4) noiseless operation.

This machine, known as the Everett-McAdam Blue-Print Machine, is manufactured in [illegible] sizes, viz., 60 and 48 ins., designed for paper [illegible] and 42 ins. respectively, by the Revolute Machine Co., 523 West 45th St., New York City.

THE CORONER'S INVESTIGATION OF THE ATLANTIC CITY DISASTER.

Further testimony in the concluding [illegible] of the coroner's investigation at Atlantic City after our last week's issue went to press gave corroborative proof that the cause of the disaster was a raised rail at the end of the drawspan.

Lloyd Byers, an electrician who was employed on the construction of the bridge, testified as follows, according to the report published in the Philadelphia "Public Ledger" of Nov. 6:

"One of those rails stuck very often while I was at work on the bridge during July, August and September," said Byers. "In fact, it stuck the majority of times the draw was operated. It jammed on the corner of the flange about half an inch. Only one seemed to do this. It was the outside rail, the one that was battered and twisted by the train at the time of the wreck. It might have been crooked or shifted. The rails would not have to be in position for the semaphore to have worked. If that rail stuck on the corner of the shoe it would not have affected the semaphore."

Frazier Bates, the track foreman, testified that several complaints came to him in August about the rails sticking at the Thoroughfare drawbridge and he finally had to cut one of them off.

The following is an excerpt from the testimony of David H. Lovell, Superintendent of the West Jersey & Seashore R. R., as reported in the Philadelphia "Press":

Q—When the West Jersey selected their bridge for the Thoroughfare did they select the bridge for the safety of the public? A—We always construct the operations on our line with a view to safeguarding and protecting the riding public. This bridge was not constructed for the electric line alone, but is made for use of the steam road also, and to bear trains going at the rate of sixty miles an hour. The bridge is the very best that we could build, and designed by our own company, and right here I might say that our line is not an electric road in the sense that is applied to trolley systems, our line is the best electrically equipped road in the world to-day. Its construction has thus far cost $6,000,000. It is equipped with the safest electric signal system obtainable, and in the matter of safety appliances is fitted out as no other electric road.

Q—How about the draw, is that the very safest you could construct? A—My statement also applies to the draw.

Q—Would you not consider guard rails as an additional protection to the public? A—The question of guard rails is a debatable one. We think that the presence of guard rails on bridges provides an element of danger. If something should fall off a moving train and get wedged in between the tracks and the guard rails, it would cause instead of prevent an accident, and for that reason we have not put guard rails on our bridges.

Q—From your observations do you think that if there had been a guard rail on that bridge it would have prevented the train from going overboard? A—I do not. I don't think that a guard rail could have saved it.

Q—As a result of your investigation, can you tell us what in your opinion caused the accident? A—I say to you truthfully and honestly that I do not know what the cause was. I'd like very much to find out.

Q—You heard all the testimony that has been presented thus far, and as an experienced railroad man and engineer, don't you think you ought to be able to say what the cause was? A—I may think one thing or another, but I don't know positively.

On Nov. 7 a practical demonstration of the fact that the interlocking permitted a clear signal to be given while a rail was displaced was made at the bridge and is reported as follows in the "Public Ledger":

When the Coroner demanded a practical demonstration of how one of the drawbridge rails could have been protruding above the tracks, while the others were securely locked in their places, Superintendent Lovell evinced a marked reluctance to make the demonstration. Three times the Coroner insistently made the request.

"I do not think that it can be done," said the superintendent, when Gaskill explained his purpose; "I do not think the signals will show an open track when one of the rails is up."

But Superintendent Lovell was wrong, as was shown a few minutes later. One of the jurymen used a crowbar to displace the outside rail after the ends had been elevated. Then the signal was given to "lower away." Three rails settled into their places and the lock was sprung. The fourth rail remained protruding above the track line. Suddenly the automatic signal clicked and the white semaphore showed "clear."

"That is enough. Are you satisfied, gentlemen, that the open track signal could have been given while the end of a rail stuck up as this one is doing now?" asked the Coroner.

The jurymen were satisfied and said so.

On the same day James N. Whitman, an expert engineer summoned by the coroner, testified that his examination of the pilot on the front car of the wrecked train showed an indentation where the raised rail had struck it. Quoting again from the "Public Ledger" report:

"The guard bar on the truck was parted by a sharp object and the casing was indented," said Mr. Whitman. "If the end of that rail was cut off and placed in the

indentation you would find that it fits perfectly. I am certain that it was the end of the rail which was struck by the front of the truck. The movement of the rail would necessarily have been inward to the position in which it lay after the wreck."

Other reports of Whitman's testimony state that marks of collision with the end of the raised rail were also found by him on the motor casing of the front truck.

The verdict brought in by the coroner's jury after spending seven hours in discussing the evidence was as follows:

"We find that the said Walter C. Scott came to his death on Sunday, October 28, 1906, by the derailment and the plunging into the waters of Beach Thoroughfare of the electric train that left Camden at 1 o'clock on said date, said derailment being caused by the northwest end of the southwest rail on the draw of the bridge over Beach Thoroughfare, in or near Atlantic City, in said county, being out of proper position, due, we believe, to the neglect or oversight of the man in charge of the draw. We strongly recommend that the men employed to operate the drawbridge inspect, each with the other, both ends of the draw before the signal is given for trains to pass the opening ends of the draw.

The manner in which this verdict was taken by the public is shown by an Atlantic City dispatch published in the Philadelphia "Press" of Nov. 8, which we reprint nearly in full as follows:

Atlantic City, Nov. 8.—Indignation is intense in this city because of the failure of the Coroner's jury to even censure the West Jersey & Seashore R. R. Co. for the awful wreck at the Thoroughfare on Oct. 28, in which 57 lives were lost when an electric train on the new line leaped from the bridge into the water.

Opinion is general that a scapegoat is being made of Daniel Stewart, the aged bridge tender, upon whom the jury's verdict placed the responsibility for the disaster. After the verdict there was doubt among the Coroner and other officials as to arresting Stewart. There was nothing but pity for the old man, and it was believed he should continue at liberty until the Grand Jury, now in session, should act in the case. But after a conference in May's Landing to-day between Coroner Gaskill and County Prosecutor Abbott it was decided the Coroner's jury's action called for the arrest of Stewart at once.

Upon his return Coroner Gaskill said:

I intend to reserve the taking into custody of Stewart for myself, as I don't want to see the old man go to jail. In fact, if his friends cannot raise the bond that will be demanded to insure his appearance before the Grand Jury I will take enough interest myself to secure his release. I am still of the opinion that throwing the blame entirely upon him is an outrage.

I want to see the railroad officials make some move to change the mechanism of the signals, which do not protect the passengers against a repetition of the accident. It has been established that the signals now used can show a clear track when the bridge is not safe.

When the verdict of the jury was announced no one was more surprised than the Coroner. He said:

Gentlemen, you don't mean to place all the blame on the bridge-tender?

For a moment none of the jurors replied. Finally one said:

"Well, that's what all the evidence shows."

"But you have said nothing in your verdict about the construction of the bridge. You say the accident was caused by a rail not being in place, but you don't say what caused that rail to be out of place."

"Why, yes we do," answered one of the jurors. "We say it was out of place because the bridge tender did not attend to his duties."

"But isn't there another reason? Had that rail any business to be out of place? If that bridge had been properly constructed could that rail have been out of place? You make no mention of this part of the case."

"We have nothing to do with the construction of the bridge. We are not experts. We have only to deal with the facts. Besides, from what I understand of the testimony, the Pennsylvania Railroad does not expect all those rails to fall back into place every time the draw is opened. The same defect, according to the testimony, is to be found on all drawbridges. That's why the railroad people have a man there to look after the rails."

This argument almost stunned the Coroner. When he recovered his breath he promptly replied:

"The testimony submitted by the railroad officials shows that all the rails on that drawbridge were supposed to fall into place and interlock with the other rails before the signals could be set showing a clear road. It was demonstrated, to you to-day that it was not necessary for all eight rails to lock in order to operate the signals. You saw that the outer rail on the southbound track failed to fall back into place, and yet the semaphore signals were operated and set to show a clear road. Gentlemen, what would you call that?"

AN ELECTRIC CANAL TOW BOAT which has been used on some of the German canals with good results consists of a triple-screw tug, the center propeller driven by a 25-HP. motor and the outer propellers by 20-HP. motors. By grouping the propellers in different ways speeds from 200 to 500 r. p. m. can be obtained. The tug is normally operated from an overhead trolley system erected along the bank, but it carries sufficient storage battery power to enable a good speed being maintained over a considerable distance without the use of the trolley current. The battery has a capacity of 224 amp.-hrs. One man is all that is required to manipulate and steer the tug.

TESTING ALTERNATING-CURRENT APPARATUS BY THE BEHREND METHOD.*

The Behrend method of testing alternating-current generators and synchronous motors under full-load conditions while they are still in the shop, differs from the usual method in that the results are obtained by circulating the power generated within the machine itself. The advantages of this method over the older one in which two machines of the same capacity are required and which involves the expenditure of power corresponding to the losses of two machines, are at once evident.

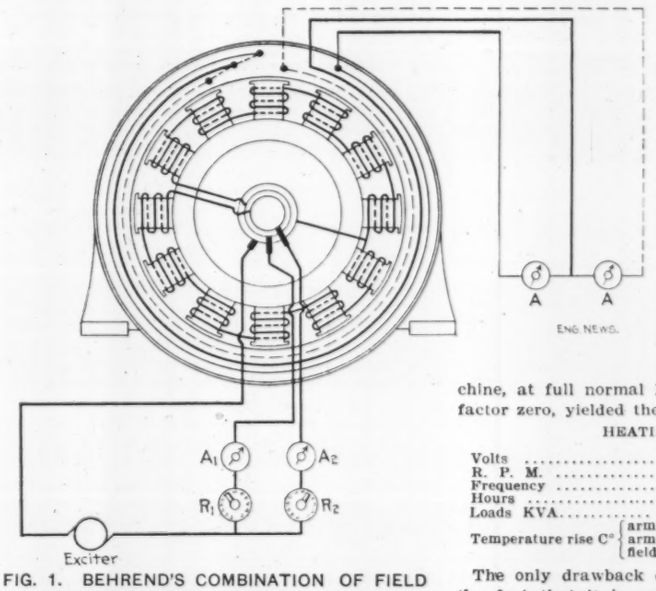


FIG. 1. BEHREND'S COMBINATION OF FIELD COILS FOR CIRCULATING POWER IN TESTING ALTERNATING CURRENT MACHINES.

The first to suggest the circulation of power within a single machine for the purpose of testing it, was Mr. William M. Mordey.† His method consisted in dividing the armature winding in two sections and connecting these sections in opposition. This method cannot be used in modern generators on account of the magnetic unbalancing of the machine. To circulate power successfully within a single machine it is necessary to obtain uniform induction in the air-gap of both the motor and the generator poles. As the armature reaction strengthens the motor poles and weakens the generator poles, the impressed excitation of the motor poles must be smaller than the impressed excitation of the generator poles, and this is effected by Mr. Behrend as shown in Fig. 1 by splitting the field coils into two sets equal in number and excited with different field currents.

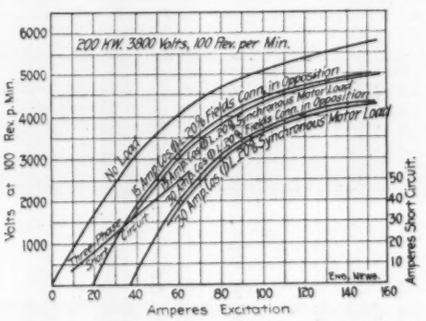


Fig. 2. Comparison Between Regulation Curves Obtained by Synchronous Motor-Generator Test by Behrend Method.

*Mr. B. A. Behrend, who devised the method here described is Chief Electrical Engineer of the Allis-Chalmers Co. His method is patented.

†See paper by Mr. Mordey in the Journal of the British Institution of Electrical Engineers, Vol. II, 1893.

Fig. 2 shows the regulation curves on low power-factor obtained by first running a synchronous motor from the generator, and secondly, by circulating power within the machine itself. The agreement between the two methods is, obviously, very satisfactory.

Numerous tests have been made to ascertain the actual losses in operating a machine in the manner described by splitting the field. Fig. 3 shows the comparison between the core loss of a machine, as determined in open circuit run, with losses as obtained in the split-field test; one set of readings is shown by the open dots, the other by the dark ones. These tests were carried out on a 1,000-KW., 25-cycle, 32-pole alternator.

The heat runs obtained by this method on a 3,500-KW. machine and on a 3,200-KW. machine, at full normal load in KVA. and power-factor zero, yielded the following results:

HEATING TESTS.

		3,500-KW.	3,200-KW.
Volts		6,600	4,500
R. P. M.		75	75
Frequency		25	60
Hours		18	23
Loads KVA.		3,500	3,870
Temperature rise C°	armature surface	30°	27.5°
	armature coils.	34°	31.5°
	field coils.	34°	31.5°

The only drawback of the method consists in the fact that it is applicable only to machines having a comparatively large number of poles. It has not been successfully applied to machines having fewer than eight poles. The application of this method is confined to machines of the slow-speed type, and with the advent of the steam turbine generator, new methods will have to be devised to produce artificially full-load losses without the expenditure of full-load power.

We are indebted to the Allis-Chalmers Co. for the illustrations and information here given.

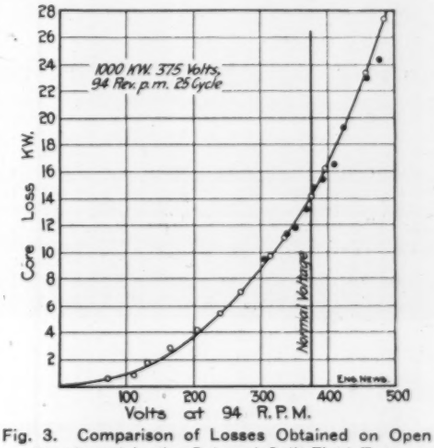


Fig. 3. Comparison of Losses Obtained on Open Circuit and in the Behrend Split-Field Test.

FIRE TESTS of windows of wired glass, by the British Fire Prevention Committee, again demonstrates that window openings fitted with this style of glass will prevent, for at least 90 minutes, the passage of flame that may continue to burn against one side. The panes tested were about two feet square and ¼-in. thick, rolled plate wired glass, polished plate wired glass, rough plate wired glass and "Maze" wired glass being used in different openings. The maximum temperatures noted on the interior ranged from 1,400° to 1,550° F., while in one case a temperature of 1,275° F. was recorded outside the pane, which, however, remained intact. The glass in all the openings was cracked, but only in one instance did flames pass through. The glass used in these tests was the product of the Mississippi Wire Glass Co., of New York City.

A SIMPLIFIED METHOD OF LAYING OUT TRANSITION CURVES.*

By Thomas Alexander Ross.†

In countries where the engineer is entirely dependent on native chainmen, the ordinary routine work of laying out transition curves is considerably increased by the difficulty of explaining to the men the odd feet and inches into which the chain may have to be divided at the half, quarter and three-quarter lengths. In such countries, therefore, it is desirable that the length of the transition curve should be represented by a whole number readily divisible into the fractions desired.

The length of the transition curve is based upon the adopted superelevation of the outer rail, for various degrees of curvature, and on the rate at which that

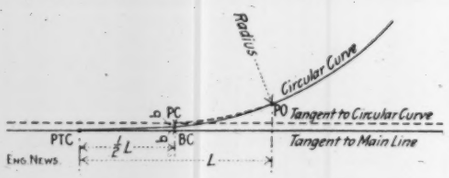


Figure Showing Manner of Laying Out Transition Curves for Railways.

superelevation is run out. Both of these factors depend upon the probable speed of the trains, but as this varies between wide limits an approximate average speed has been adopted.

For use on railways in China, where the ordinary speeds for many years to come are likely to range between 15 and 45 miles per hour, the author has worked out the accompanying transition curve table, which gives values of L, the length of the transition curve, in exact multiples of 10 ft. for curvatures expressed in even multiples of quarter degrees. The curve adopted is the cubic parabola, and the table has been compiled for an average train speed of about 30 miles per hour, with superelevation calculable by the usual formula, $E = \frac{GM^2}{1.25\ R}$, run out at the rate of ⅞-in. in 60 ft.

In practical field work, however, it is generally sufficient, at first, to mark only the beginning of the transition curve, its middle point, and the point where it joins the circular curve, i. e., the point of osculation. These can be found in the following manner: With the instrument at the apex point, lay off the B.C. and E.C. (beginning and end of curve) for a circular curve in the usual manner (see accompanying figure). A further distance equal to ½ L measured out on each tangent gives the P.T.C. (point of transition curve) and E.T.C. (end of transition curve). At B.C. set off at right-angles to the tangent a distance b, equal to the ordinate at ½ L, or to half the "shift." This gives the middle point of the transition curve; continue this offset a further distance equal to b. This will give P.C. (the point from which the circular curve can be set out). With the instrument at this point, and a backsight parallel to the original line, lay off the circular curve, the first deflection being worked out for ½ L. This will give P.O. (the point of osculation), or the point at which the transition curve and the circular curve join. The three points thus located are all that is required until the formation is finished, when reference points (generally stones having crosses cut on their tops) can be laid out by ordinates or deflections at the quarter and three-quarter lengths.

It will be seen that the length in feet of the transition curve given in the table is equal to the deflection of the curve in degrees multiplied by 40. This length can therefore be obtained by a simple mental computation, at any time, without reference to the table.

TRANSITION-CURVE TABLE SUITABLE FOR SPEEDS OF ABOUT 30 MILES PER HOUR ON A GAGE OF 4 FT. 8½ INS.

Deflection of Curve.	Elevation of Rail.	L Length of Transition Curve.	First Ordinate at ¼ L.	Second Ordinate at ½ L.	Third Ordinate at ¾ L.	Fourth Ordinate at L.	S Shift.	Deflection Angles for ¼ L.	Deflection Angles for ½ L.	Deflection Angles for ¾ L.	Deflection Angles for L.
° ′	Inches.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	′ ″	° ′ ″	° ′ ″	° ′ ″
3 0	1⅜	120	0·02	0·158	0·54	1·26	0·32	2 30	0 9 0	0 20 30	0 36 0
3 15	1½	130	0·025	0·200	0·68	1·60	0·40	2 40	0 10 30	0 24 0	0 42 20
3 30	2	140	0·031	0·250	0·84	2·00	0·50	3 0	0 12 40	0 27 40	0 49 0
3 45	2⅜	150	0·038	0·307	1·04	2·46	0·62	3 30	0 14 0	0 31 50	0 56 20
4 0	2⅝	160	0·046	0·37	1·25	2·96	0·74	4 0	0 16 0	0 36 0	1 3 40
4 15	2⅞	170	0·056	0·45	1·52	3·56	0·89	4 30	0 18 0	0 41 0	1 12 0
4 30	2⅞	180	0·067	0·53	1·79	4·25	1·06	5 0	0 20 15	0 46 0	1 21 0
4 45	2⅞	190	0·078	0·62	2·10	4·97	1·24	5 40	0 22 30	0 50 40	1 30 0
5 0	2⅞	200	0·091	0·73	2·46	5·83	1·46	6 15	0 25 0	0 56 20	1 40 10
5 30	3⅛	220	0·121	0·97	3·28	7·76	1·94	7 40	0 30 20	1 8 20	2 1 20
6 0	3⅜	240	0·158	1·26	4·25	10·10	2·52	9 0	0 36 0	1 21 0	2 24 50
6 30	3⅝	260	0·196	1·57	5·30	12·60	3·14	10 20	0 41 30	1 33 20	2 46 30
7 0	4	280	0·250	2·0	6·75	16·0	4·0	12 15	0 49 0	1 50 40	3 16 30
7 30	4⅜	300	0·308	2·46	8·30	19·70	4·93	14 0	0 56 30	2 7 0	3 45 0
8 0	4⅝	320	0·372	2·98	10·01	23·80	5·96	16 0	1 4 0	2 24 40	4 15 20
8 30	5	340	0·446	3·57	12·00	28·60	7·14	18 0	1 12 0	2 42 0	4 48 20
9 0	5⅜	360	0·533	4·26	14·40	34·20	8·52	20 20	1 21 20	3 4 40	5 25 40
9 30	5⅝	380	0·627	5·02	16·95	40·20	10·03	22 40	1 30 40	3 24 20	6 2 20
10 0	5⅞	400	0·740	5·92	20·00	47·40	11·85	25 20	1 42 20	3 49 0	6 45 0

*From the "Transactions" of the Institution of Civil Engineers.

†Box 185, British P. O., Shanghai.

DISCUSSION ON WATER FILTRATION AND TYPHOID FEVER AT WASHINGTON, D. C., BEFORE THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

A considerable part of our space last week was devoted to an abstract of the paper on "Works for the Purification of the Water Supply of Washington, D. C.," by Allen Hazen and E. D. Hardy, M.'s Am. Soc. C. E., presented on Nov. 7 to the American Society of Civil Engineers, and also to reports by Mr. Theodore Horton, M. Am. Soc. C. E., and Prof. Wm. T. Sedgwick, on the typhoid situation in Washington. The whole of the evening session of the American Society of Civil Engineers on Nov. 7 was devoted to the presentation of Messrs. Hazen and Hardy's paper and to a lengthy discussion of the paper, which lasted until after 11 o'clock. (For the full paper see Proc. Am. Soc. C. E., Sept., 1906, p. 587.) The greater part of the discussion related to typhoid conditions in Washington and most of the speakers on this subject agreed that the continued prevalence of typhoid in that city was not in any way connected with the filter plant, but that instead the typhoid this year would have doubtless been much higher had not the filter plant been in operation. The only questions raised regarding the filter plant and its relation to typhoid were submitted by letter by Dr. Wm. C. Woodward, Health Officer of the District of Columbia. Dr. Woodward wished it understood, however, that he had no criticisms to make of the design or operation of the plant; but he failed to recognize any evidence that the filter plant thus far had had any effect upon typhoid. He questioned whether coagulation [suggested in the paper for use during periods of high turbidity] would reduce the net cost of purifying the water supply. He thought the turbidity was already low enough for all practical and reasonable esthetic purposes, and that rather than spend more money upon its further reduction attention might better be given to strictly sanitary needs of the city, such as the provision of municipal bath houses and other agencies having a direct relation upon public health. He urged that those in favor of coagulation bear the burden of the proof of its advisability, and stated that there was no evidence to show that the system of water purification recommended by the Medical Society of Washington (slow sand filtration, alone) was not capable of giving satisfactory results as regards removal of bacteria and turbidity.

Mr. F. F. Longley, Chief Chemist of the Washington filtration plant, sent in a long and valuable discussion showing that he had given very close and intelligent study to the whole subject. He thought it quite evident that sewage pollution is not always present in appreciable quantities in the Potomac River water, but that filtration is needed, as shown by the high typhoid following the Cumberland epidemic of 18[illegible]. He then placed responsibility for existing typhoid in Washington upon such of the public wells as are shallow, upon the milk supply, upon vegetables, etc., from truck gardens, and stated that the large colored population was conducive to the spread of typhoid by contact. The ice supply he did not consider a material factor in the case, and shell-fish he regarded as unimportant since the high typhoid coincided with low shell-fish consumption. As to the effect of the colored population, he presented tables of typhoid death rates of a number of Southern cities, showing that the typhoid rate was much higher among the colored than among the white population in other Southern cities as well as in Washington.

Dr. G. Lloyd McGruder, a physician of Washington who was largely instrumental in arousing public sentiment to the necessity of filtration and in securing the authorization of a filtration plant by Congress, reviewed at length the typhoid situation for many years past. He was strongly of the opinion that other causes than the water supply are responsible for the continued prevalence of typhoid since the filters were put in operation. He contributed the important recent news that on Oct. 28, 1906, a serious outbreak of typhoid was prevailing in Cumberland, Md., and that since that date the typhoid in Washington had not risen as it did to such an alarming extent after the Cumberland outbreak of 1890; consequently he thought the filtration plant had saved the city this year. Dr. McGruder devoted considerable time to the milk supply of Washington in relation to typhoid. He stated that there had been 25 cases of typhoid this year on the route of one dairyman, 10 on another route, and some on still other routes, where it was known, at least in the first two cases, that there had been typhoid in the family or among the workmen of the dairy. He said that the milk supply of the District comes from some 900 farms, and that the dairy inspection force of the Health Officer is inadequate to properly inspect these farms. Moreover, the lack of a bacterial laboratory hampers the Health Officer in his work—although other bacterial laboratories in the District are at his command. Of 46 dairy water supplies analyzed chemically in one year, 25 were condemned as unfit for use. The temperature of the Washington milk supply this summer was high and the bacterial counts of the milk in many instances ran to enormous figures.

Professor Sedgwick spoke, by request, but as the hour was late he confined himself chiefly to a statement of the main facts brought out by his own and Mr. Horton's investigation, published in our last issue. He said in conclusion that Washington to-day is well protected and doubly protected by its filtration plant against typhoid outbreaks on the drainage area of its water supply.

In the course of a communicated discussion Dr. Kober, of Washington, expressed as his belief that 15% of the typhoid in Washington is brought in by people returning from summer resorts, another 15% is due to the milk supply, and 20% is due to flies, direct infection by personal contact, fruit, vegetables, etc.

Mr. Theo. A. Leisen, M. Am. Soc. C. E., Chief Engineer of the Water Department of Wilmington, Del., sent a communication in which he outlined briefly the experimental water filtration plant now in operation in that city. This includes tests of preliminary mechanical and slow sand filters. It is too early for definite conclusions, but thus far it appears that the bacterial results do not differ materially, whether or not the water is pre-filtered; clarification is somewhat better, and the cost of operation is lessened by preliminary treatment. In the course of another written discussion it was suggested that use might be made of mechanical scrapers for cleaning the surface of filter beds, thus considerably reducing the cost.

CIVIL SERVICE FOR ENGINEERS.

By Myron H. Lewis,* C. E.

In reviewing the large amount of material collected while preparing the appendix to the "Manual of Examinations for Engineering Positions," it appeared to the writer that some of the data would be of interest to the readers of Engineering News. That the civil service system has had a great influence in broadening the field for engineers in various parts of the country is generally known, but the extent to which such service has absorbed engineering graduates is perhaps not fully appreciated.

The classified Civil Service of the United States embraces about three thousand engineering positions of all classes, divided about as follows:† (Condensed from "Opportunities for Engineering Graduates in the Federal Service," by John F. Hayford.)

700 under Chief of Engineers United States Army.
200 connected with navy yards and stations.
400 on Geological Survey work.
200 on patent examining work.
150 on Coast and Geodetic Survey work.
150 on General Land Office work.
800 on Panama Canal and miscellaneous work not included in the above.

The compensation in the Federal Service ranges as follows:

46% receive	$700 to	$1,400	per	annum
32 " "	1,500 "	1,900 "	"	"
18 " "	2,000 "	2,900 "	"	"
3 " "	3,000 "	3,900 "	"	"
1 " "	4,000 and over		"	"

The Civil Engineering Staff of the state of New York consists of about three hundred members, distributed about as follows:

3 Deputies	$4,000 to	$5,000	per	annum
3 Division engineers	3,000		"	"
16 Resident engineers	2,400		"	"
7 Bridge designers	1,500 "	3,000	"	"
40 Draftsmen	600 "	1,800	"	"
3 First assistant engineers	7.00		per	day
85 Assistant engineers	5.00 to	6.00	"	"
34 Levelers	4.00 "	5.00	"	"
27 Rodmen	3.50 "	4.00	"	"
36 Chainmen	2.50 "	3.00	"	"
12 Inspectors and foremen	3.50 "	4.00	"	"
34 Miscellaneous				

The Civil Engineering Staff of the city of New York contains almost as many members as the entire engineering force of the Federal government, and indicates clearly the vastness of the public enterprises under way and the marvelous expansion that is taking place in the city. The accompanying table gives the classification, compensation and distribution of civil engineering employes in the several departments of the municipal service. The figures are roughly approximate (and are based on the City Record of Jan. 1, 1906). There has since been a large increase in the staff of the Board of Water Supply.

Salaries in other municipalities compare favorably with those in the city of New York (expense of living, etc., being considered), as is shown by the following:

Engineering Staff of the City of Buffalo.

1 Deputy commissioner	$3,000	per	annum
1 Assistant engineer	2,500	"	"
2 " "	2,400	"	"
2 " "	2,000	"	"
3 Assistant engineer	$1,800	per	annum
2 " "	1,500 to 1,600	"	"
8 Transitmen	1,200	"	"
12 Rodmen	900	"	"
2 Draftsmen	1,100	"	"

Staff of the City of Los Angeles, Cal.

1 Chief deputy	$200	per	month
1 Office engineer	7.00	per	day
1 Field engineer	7.00	"	"
1 Chief draftsman	7.00	"	"
3 Engineers, 1st class	6.50	"	"
4 Engineers, 2d class	5.00	"	"
8 Surveyers	5.00	"	"
3 Surveyors	4.00	"	"
20 Draftsmen and computors	$4.00 to 5.50	"	"
13 Instrumentmen	3.00 " 3.50	"	"
16 Inspectors	4.00	"	"
2 Sewer superintendents	90 " 125	per	month

Boston Civil Engineers, Salaries.

Chainmen and rodmen, up to	$800	per	annum
Levelers, transitmen, etc., up to	1,100	"	"
Assistant engineers—			
Junior grade, up to	1,600	"	"
Senior grade, over	1,600	"	"
Draftsmen—			
Junior, up to	800	"	"
Senior, up to	1,300	"	"

A large number of other municipalities and state governments have extended the principles of Civil Service by organizing their technical staff, the details of which the writer hopes to obtain later. It is, however, not very far from wrong to estimate that nearly ten thousand engineers of all classes are now employed in the service of the municipal, state and federal governments, entrance to which is largely by competitive examination. While in many special cases the character of the examinations may be fairly criticized, the great majority of the Question Papers, which the author has reviewed, nearly 150 in number, are well suited to test the fitness of the applicants for the positions sought. Although examinations in themselves are never conclusive tests of ability, and have many well-known defects, the constantly increasing acceptance of the merit system is rapidly making Civil Service one of our basic institutions.

It is somewhat surprising that considering the large percentage of engineering graduates who enter government employ no official notice of Civil Service examinations has been taken by the leading colleges. It would inure to the benefit of all three, the college, the service and the student, to familiarize the latter with the character of the examinations, requirements for admission, etc., and would form not the least interesting subject in the final year of the course.

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†From Appendix to "Manual of Examinations for Engineering Positions in the City of New York." New York: Engineering News Publishing Co.

THE LIFE OF POWER STATION EQUIPMENT, with respect to the various parts, was given recently by Sir William Preece in a report on the equipment of the Bristol, England, municipal power station. This station, although containing much modern machinery, among which were several steam-turbine-driven alternators, needed enlargements and alterations, and the report was in response to questions from the municipality as to the probable life of all parts of the equipment if properly maintained and their value at the end of this life. According to Sir William, the life of dynamos and alternators is 30 years, and their value at the end of that time is 8%. The life of motors is 25 years and their residual value 9%. Armored cables are allotted 35 years and then have a value of 15%. Storage batteries are given a life of 15 years and a residual value of 10%; arc lamps, 12 years; lamp-posts, 40 years, and meters and accessory instruments of a similar kind, 12 years. Water-tube boilers are given a life of 25 years and a residual value of 5%, and the engines and other machinery are given 25 years and a residual value of 6%.

EXPERIENCE WITH MAGNETIC BRAKES ON ELECTRIC CARS IN NEW SOUTH WALES.

The magnetic brake of the Westinghouse-Newell type for electric railways has shown very satisfactory results in tests made at Sydney, New South Wales, under the direction of the Railway Commissioners of the colony, the Sydney street railways being owned and operated by the government. The tests were made partly on account of complaints made against the brake, and the report states that of 20 witnesses who had experience with both the magnetic and air brakes, 6 preferred the air brake for service stops (as bringing the car to rest more smoothly), while 7 preferred the magnetic brake, and the others had no preference; all of them, however, preferred the magnetic brake for emergency stops. During the year ending June 30, 1906, air-braked cars ran 14,073,485 miles, and 1,642 cars were withdrawn on account of brake troubles, making 8,570 miles run to each case of brake trouble. The cars with magnetic brakes ran 1,018,848 miles, with 59 cars withdrawn, or 17,133 miles per case of trouble with brakes. These latter cars operate on heavier grades than the air-braked cars. The enquiry and tests were conducted by a Board composed as follows: Mr. O. W. Brain, Electrical Engineer of the New South Wales Railways and Street Railways; Prof. Pollock, of Sydney University; Mr. T. Roberts, Chief Mechanical Engineer of the South Australian Railways; Mr. J. S. Badger, Manager of the street railways of Brisbane (Queensland); and Mr. H. J. Somerset, Engineer and Manager of the street railways of Perth (Western Australia):

The most important cause in connection with the failures had been the breakage of the earth wire leading from the magnet coil. This, as supplied by the makers, consisted of an insulated cable. As the lead was necessarily subjected to a great deal of vibration, the copper conductor was apt to become fatigued and to break. With a covered cable the development of the breakage was not apparent to inspection. The Board was satisfied that the course being taken by the Department of substituting bare cables in duplicate for the existing single insulated cable would eliminate this cause of failure.

With new appliances generally, defects might exist which were eventually discovered and eliminted. Many of the complaints, were, no doubt, due to the men having to handle a new appliance. The use of the Westinghouse-Newell brake imposed a certain amount of additional work on the part of the driver in operating the hand-brake, and, naturally, that was an objection from his point of view. As this brake was of comparatively recent adoption, the Board could understand that some of the men, when first handling it, did not feel the confidence they would gain after greater experience; but in the Board's opinion, when they were as familiar with this brake as they were with the air brakes, they would be equally confident and expert in its use. The evidence submitted showed that this was already the case with most of the drivers examined.

The publication of circumstantial statements to the effect that the presence of dirt on the rail interposed resistance in the circuit, which would tend to prevent the motors from exciting, and thus render the brake inoperative, might have given rise to some apprehension. As the occasional presence of dirt on the rail was unavoidable, the brake would be entirely unreliable if this assertion were correct. The Board therefore consider it advisable, in order to reassure the drivers and the public, to state in the plainest possible language, that no such

TABLE SHOWING APPROXIMATE NUMBER OF CIVIL ENGINEERING EMPLOYEES IN THE CLASSIFIED CIVIL SERVICE OF THE CITY OF NEW YORK, JANUARY 1, 1906.

Position.	Finance, taxes and law dept's.	Aqueduct Commiss'n	Board of Estimate.	Dep't of Bridges.	Dep't of Docks.	Dep't of Water Supply, Gas and Elec.	Dep't of Parks.	Rapid Transit Commiss'n	Board of Water Supply.	President Borough of Manhattan	President Borough of Bronx.	President Borough of Brooklyn.	President Borough of Queens.	President Borough of Richmond.	Board of Education.	Total.	Compensation in most cases.	Remarks.
Assistant Engineers.	6	27	6	35	18	34	4	88	15	20	49	34	26	14	....	376	$1,200 to $3,000 per annum.	Includes about 50 Chief and Deputy Chief Engineers, $4,000 to $16,000
Transitmen and Computers	15	8	....	10	11	12	....	....	6	6	31	18	5	7	....	129	$1,200 to $1,800	.....
Draftsmen (Structural, Architectural, Topographic and Mechanical)	29	....	1	17	24	28	1	25	6	6	31	29	46	20	130	388	$900 to $2,700	Majority $1,200 to $1,800
Levelers	....	14	....	7	10	16	1	....	5	5	18	8	1	25	....	110	$1,200 to $1,800	.....
Rodmen	....	8	3	6	10	14	2	100	15	5	31	12	5	25	....	246	$900 to $1,200	.....
Axmen	....	35	6	6	....	14	....	50	24	9	34	6	1	20	....	205	$720 to $900	.....
Inspectors (Masonry, Building, Steel and Paving) etc.	8	32	....	17	....	50	4	65	....	160	155	160	33	12	70	766	$4 to $7 per day, $1,200 to $1,500 per annum	Does not include over 500 Inspectors (Plumbing, Sanitary, Pile Driving, Tenement House.)
Totals	58	134	16	98	73	163	12	328	71	211	349	267	117	123	200	2,220		

risk existed. The contact of the car-wheel or track-shoe with the rail did not form any part of the Westinghouse-Newell brake electric circuit. After careful consideration of all the evidence taken and observation of the tests to which the brake was subjected, the Board found it prompt in its application, effective in its action, and exceptionally powerful in making emergency stops. They also found that the allegations made as to its unreliability were disproved, and that there was no reason for fear on the part of the public or of the staff in regard to the efficiency of the magnetic brake.

The Board examined into every reported case of failure of the brake since its introduction in January, 1905, to July 15, 1906. These comprised a total of 66 cases, which might be summarized as follows: Absolute failures, rectified, 20 cases; brake working unsatisfactorily and requiring adjustment, and cause found, 18; absolute failure reported, but equipment found in good order, 6; brake reported unsatisfactory or out of order, but equipment found in good order, 7; cases reported as failures which were not attributable to the brake, 15 cases.

PRELIMINARY EARTHWORK ESTIMATION WITH THE SLIDE RULE.

By C. W. Crockett.*

1. In preliminary railway location, where the cross sections are determined by measuring the transverse slope, or slopes, of the surface, the volumes in excavation and in embankment may be determined with the requisite accuracy by the use of the slide rule.

The transverse slope of the ground on either side of the center line may be determined in one of two ways: (a) the rise or fall in going a given horizontal distance, say 10 or 20 or 30 or more feet, from the center may be measured and then the tangent of the angle ϕ' or ϕ'' found by dividing the rise or fall by this horizontal distance; or (b) the angles ϕ' and ϕ'' may be measured with a clinometer. The slide rule devised by the writer,† and described in Engineering News, Dec. 21, 1905, is applicable both to thorough and to side hill work when the transverse slope is determined by method (a); if the transverse slope is determined by method (b), the J. M. Rudiger Volume Slide Rule‡ may be used for thorough work, when the side slope ratio has certain particular values.

2. Let the center height in cut be h_c, the volume in cut be V_c, and the width of the roadbed in cut be w_c, the subscript c indicating that the quantities are in cut. Similarly let h_f, V_f and w_f be the corresponding quantities in fill. Then the height in cut h_c and the volume in cut V_c have *like* subscripts c, and the height in cut h_c and the volume in fill V_f have *unlike* subscripts c and f. In this sense let

V_l = volume with subscript *like* that of the center height,

V_u = volume with subscript *unlike* that of the center height,

w_l = width of the roadbed with subscript *like* that of the center height,

w_u = width of the roadbed with subscript *unlike* that of the center height,

and so also with the other letters.

s = side slope ratio, horizontal ÷ vertical,

s' = side slope to ratio, vertical ÷ horizontal = $1 \div s$,

and let L be the distance between two adjacent cross-sections.

In the figure, considering first the portion C C_1 R B on the right of C_1 C, we have $h_c = c = C_1 C$, $w_l = C_1 R$, $s_l = \tan \theta_c$, and V_l = the volume of a right prism with the cross-section C C_1 R B and with the length ½ L. Considering the section to the left of C_1 C, we have $h_c = c = C_1 C$, $w_l = C_1 R$, $s_l = \tan \theta_c$, and V_l = the volume of a right prism with the cross-section D C_1 C and with the length ½ L; and $w_u = C_1 L$, $s_u = \tan \theta_f$, and V_u = the volume of a right prism with the cross-section L D A and with the length ½ L.

3. Then, treating each side of the center separately, and letting ϕ represent the surface slope angle on the side considered, the formulas for the volume of a right prism with a cross-section like that on one side of the center height and with the length ½ L, required in the computation of the volume by the average-end-area method, are:

I.—*Surface recedes* * *from the road bed:*

$$V_l = \frac{L}{108\ s'_l - \tan\phi}\frac{(c_o + c)^2}{} - \frac{1}{432} L\, w_l^2\, s'_l \qquad \left[c_o = \frac{1}{2} w_l\, s'_l\right]$$

$V_u = 0.$

II.—*Surface level:*

$$V_l = \frac{1}{108} L\,(c_o + c)^2\, s_l - \frac{1}{432} L\, w_l^2\, s'_l \qquad \left[c_o = \frac{1}{2} w_l\, s'_l\right]$$

$V_u = 0$

III.—*Surface approaches* * *the road bed.*†

(a) $\tan\phi < c \div \frac{1}{2} w_l$: $V_l = \frac{L}{108\ s'_l + \tan\phi}\frac{(c_o + c)^2}{} - \frac{1}{432} L\, w_l^2\, s'_l$.

$$\left[c_o = \frac{1}{2} w_l\, s'_l\right]$$

(b) $\tan\phi = c \div \frac{1}{2} w_l$: $V_l = \frac{L}{108 \tan\phi}\frac{c^2}{}$.

(c) $\tan\phi > c \div \frac{1}{2} w_u$: $V_u = \frac{L}{108\ s'_u - \tan\phi}\frac{(c_o - c)^2}{} + \frac{L}{108 \tan\phi}\frac{c^2}{} - \frac{1}{432} L\, w_u^2\, s'_u \qquad \left[c_o = \frac{1}{2} w_u\, s'_u\right]$

* In going away from the center C.

† $V_u = o$ in cases I and II, and also in Case III, unless $\tan\phi > c \div \frac{1}{2} w_u$.

4. To find the value of $\frac{L}{108\ s'_l - \tan\phi}\frac{(c_o + c)^2}{}$ with the Crockett Volume Slide Rule the following setting is used: In the same radial line with $c_o + c$, found on scale S, set L, found on scale B; then in the same radial line with $s'_l - \tan\phi$, found on scale B, read on scale A the value of the expression.

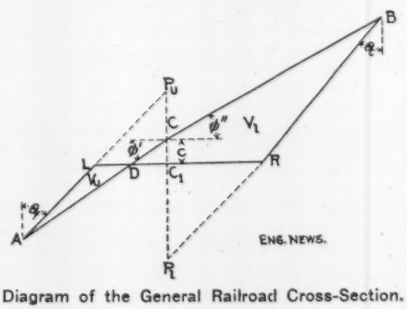


Diagram of the General Railroad Cross-Section.

5. Placing the names of the scales in the order, from left to right, in which they are used, and, beneath them, the quantities used, and letting $\frac{1}{4} G_l = {}^1/_{432}\, L\, w_l^2\, s'_l$ and $\frac{1}{4} G_u = {}^1/_{432}\, L\, w_u^2\, s'_u$, the settings for the several cases are as follows:

I.—*Surface recedes:*

	S	B	B	A
$c_o = \frac{1}{2} w_l\, s'_l$	$c_o + c$	L	$s'_l - \tan\phi$	$V_l + \frac{1}{4} G_l$

II.—*Surface level:*

$c_o = \frac{1}{2} w_l\, s'_l$	$c_o + c$	L	s'_l	$V_l + \frac{1}{4} G_l$

III.—*Surface approaches:*

(a) $\tan\phi < c \div \frac{1}{2} w_l$.

$c_o = \frac{1}{2} w_l\, s'_l$	$c_o + c$	L	$s'_l + \tan\phi$	$V_l + \frac{1}{4} G_l$

(b) $\tan\phi = c \div \frac{1}{2} w_l$.

c	L	$\tan\phi$	V_l	

(c) $\tan\phi > c \div \frac{1}{2} w_u$

$c_o = \frac{1}{2} w_u\, s'_u$.	$c_o - c$	L	$s'_u - \tan\phi$	(1)
	c	L	$\tan\phi$	(2)*

$$\therefore V_u = (1) + (2) - \frac{1}{4} G_u$$

6. The values of $\frac{1}{4} G_l$ and $\frac{1}{4} G_u$ are found as follows:

Opp.† w_l on S, set 4 s_l on E; opp. L on E, read $\frac{1}{4} G_l$ on A; and

Opp. w_u on S, set 4 s_u on E; opp. L on E, read $\frac{1}{4} G_u$ on A.

Having made the setting, the value of $\frac{1}{4} G_l$ (or of $\frac{1}{4} G_u$, as the case may be) corresponding to each value of L should be read and placed at the proper place in the computations.

7. EXAMPLE.—The roadbed in cut be[illegible] 28 ft. wide and in fill 20 ft., and the side-slope ratio 1 to 1 in cut ($s_c = 1$) and 1½ to 1 in fill ($s_f = {}^3/_2$), let the notes for a cross-section resembling that in the figure to be

Slope.	Center height.	Slope.
$\frac{-6.0}{10}$	+ 2.0	$\frac{+5.0}{10}$

the minus sign of the slope indicating that the ground goes down from the center, and the positive that it goes up. Let the distance to the adjacent section be 60 ft., so that L = 60.

The center is in cut. On the right the ground rises and therefore recedes from the roadbed; hence we use the setting for Case I. On the left the ground approaches the roadbed so that Case III. is applicable; then

$c \div \frac{1}{2} w_l = 2 \div 14 = 0.14 +$ and $\tan\phi = 0.6$, so that Case III (b) will give the volume V_l in cut. Also

$c \div \frac{1}{2} w_u = 2 \div 10 = 0.20$ and $\tan\phi = 0.6$, so that Case III (c) is applicable, giving a volume V_u, which in this example will be in fill.

For the volume in cut $s_l' = 1$ and $c_o = 28 \div 2 = 14$; and for that in fill $s_u' = {}^2/_3 = 0.667$ and $c_o = 20 \div 3 = 6.7$ approx. Hence for the volume in cut on the left, by Case III (b).

Opp. c = 2* on S, set L = 60 on B;	
Opp. tan ϕ = 0.6 on B, read on A	$3^{19}/_{27}$
and for that on the right, by Case I.,	
Opp. $c_o + c$ = 16 on S, set L = 60 on B;	
Opp. $s'_l - \tan\phi$ = 0.5 on B, read on A	$284^{9}/_{27}$
	$288^{9}/_{27}$
Opp. w_l = 28 on S, set $4s_l = 4$ on E;	
Opp. L = 60 on E, read on A	$\frac{1}{4} G_l = 108^{9}/_{27}$
∴ Vol. in cu. yds. of right prism with cross-section D R B C and length	½ L = $179^{9}/_{27}$

For the volume on the left that is in fill (V_u), by Case III (c),

Opp. $c_o - c$ = 4.7 on S, set L = 60 on B;	
Opp. $s'_u - \tan\phi$ = 0.067 on B, read on A	183.2
Opp. c = 2 on S, set L = 60 on B;	
Opp. tan ϕ = 0.6 on B, read on A ($3^{19}/_{27}$ above)	3.7
	186.9
Opp. w_u = 20 on S, set $4s_u = 4 \times 3/2 =$ 6 on E;	
Opp. L = 60 on E, read on A	$\frac{1}{4} G_u$ = 37.0
∴ Volume =	149.9

8. When the surface is entirely in cut or entirely in fill (Cases I, II and III (a)), only one setting is necessary:

Opposite $c_o + c$ on S, set L on B; then opposite each value of $s_l' \pm \tan\phi$ on B, read the value of $V_l + \frac{1}{4} G_l$ on A.

9. EXAMPLE.—Let the transverse surface be a continuous slope, $\phi' = \phi''$, such that $\tan\phi = \frac{1}{2}$, and let c = 12 ft., $s_l = 1$, $s_l' = 1$, $w_l = 18$ ft., and the distance L to the adjacent section be 81 ft. Then $c_o = \frac{1}{2} w_l\, s_l' = 9$; ∴ $c_o + c = 21$; $s_l' + \tan\phi = {}^3/_2$; $s_l' - \tan\phi = \frac{1}{2}$.

Opp. $c_o + c$ = 21 on S, set L = 81 on B;	
Opp. $s'_l + \tan\phi = 3/2$ on B, read on A	$220\frac{1}{2}$
Opp. $s'_l - \tan\phi = \frac{1}{2}$ on B, read on A	$661\frac{1}{2}$
Sum	882
Opp. w_l = 18 on S, set 4 s_l = 4 on E;	
Opp. L = 81 on E, read on A	$\frac{1}{4} G_l = 60\frac{3}{4}$
Considering both sides of the center,	½ $G_l = 121\frac{1}{2}$
∴ Volume =	$766\frac{1}{2}$

10. If the angle ϕ of the surface slope is measured in degrees, it would be necessary to refer to a table of natural tangents before using the Crockett Volume Slide Rule. In this case, provided also that the surface does not intersect the roadbed, the volume of a right prism with a length of 50 ft., for the side slope ratios ¼ to 1, 1 to 1, 1¼ to 1, and 1½ to 1, may be found by the J. M. Rudiger Volume Slide Rule. This instrument is of the same size and form as the Crockett Rule. The base bears two closed logarithmic scales; on the outer, called A, the numbers range from 1 to 10,000, and on the inner, called H, they vary from 1 to 100. On the Rotator there are four short scales, one for each value of the side slope ratio; on each of these scales there is a line marked with an

*Professor of Mathematics and Astronomy, Rensselaer Polytechnic Institute, Troy, N. Y.

†Manufactured by W. & L. E. Gurley, Troy, N. Y.

‡Manufactured by W. & L. E. Gurley, Troy, N. Y.

*The same setting as for Case III. (b).

†"Opposite" signifying "in the same radial line with."

*If the number to be found on S is less than 4, multiply it by 10, and divide the volume found on A by 100. If the number to be found on B is less than 0.1, multiply it by 10, and multiply the volume read by 10.

arrow called the Index I. Each of these Rotator scales extends both ways from its zero line, one side being used for plus slopes in excavation and for minus slopes in embankment, and the other side for minus slopes in excavation and for plus slopes in embankment. The constants $c_o = \frac{1}{2}$ w s' and C = 50 w² ÷ 108 s are tabulated for the ordinary values of w.

The volume is found as follows:

Opposite $c_o + c$ on H, set the index I on the proper side slope scale on the Rotator;

Opposite ϕ' on this scale, read the volume V' on A; and

Opposite ϕ'' on this scale, read the volume V'' on A.

Then the volume for a length of 50 ft. (L = 100) is V' + V'' — C.

11. EXAMPLE.—In an excavation s = 1½, w = 18, c = 24, $\phi' = +5°$, $\phi'' = -8°$; $c_o = 6$; ∴ $c_o + c = 30$.

Opp. $c_o + c = 30$ on H, set I for slope 1½ to 1;
Opp. +5° for Exc., read on A V' = 1,438.8
Opp. —8° for Exc., read on A V'' = 1,032.4

2,471.2
C = 100.0

Vol. for 50 ft. length = 2,371.2 cu. yds.

A STEAM MOTOR CAR FOR THE BAVARIAN STATE RAILWAYS.

A steam motor car recently built for the Bavarian State Railways embodies a number of novel and interesting features.

The chief peculiarity is the engine, Fig. 1. It has one cylinder on each side, in which work, in opposite directions, two pistons. Each piston is respectively connected by its own cross-head and connecting rod to the front and rear pair of wheels, so that perfect balance of the reciprocating parts is secured as in a four-cylinder balanced locomotive.

The arrangement is interesting on account of obviating the oscillations that produce side lash, that is, horizontal displacements about a vertical axis. The motion of the reciprocating parts is balanced by having the crank pins set on all quarters. With this arrangement, coupled with the comparatively short cranks as compared to the connecting rods, the cranks on each side of the engine attain their maximum power four times in each complete revolution, at different points.

The connecting rods are about 26½ ins. long and cause these points to come at an angle of 78½° from the piston line, and a difference of 28° to exist between the points of maximum crank effort of the front and back cranks, respectively.

In place of the usual valve crank, a single eccentric is used to drive the expansion link. The lead lever is operated from a link attached direct to the center of the cross-head. Outside of the connecting-rods there are special coupling-rod cranks, for coupling-rods are provided to synchronize the two backward and forward motions. The coupling rods are heavy as compared with the connecting-rods.

The complete car is shown in Fig. 2. As the boiler is equipped with an automatic stoker, it enables the motor car to be worked entirely by one man. This car can haul two additional coaches of the same size at a speed of 40 miles per hr. The maximum speed is 47 miles per hr. The motor car has a seating capacity of 55, and standing room for 30. The engine develops a maximum of 350 HP., and on the level, working at full power, the coal consumption is from 17 to 21 lbs. per mile. As the bunker capacity is 1,300 lbs., a double run of a little over 30 miles each way can be made under normal conditions. Dimensions and further particulars of the steam coach and of the car are given in the table at the top of this column.

Steam Motor Car.	
Working pressure	235 lbs.
Cylinders, diameter	8 ins.
Cylinders, piston stroke	2 × 10¼ ins.
Driving wheels, diameter	39 ins.
Tractive power	3,590 lbs.
Grate area	9.3 sq. ft.
Heating surfaces (inside):	
Fire-box	37.3 sq. ft.
Tubes	405.6 sq. ft.
Total	442.9 sq. ft.
Superheater surface (fire contact)	74.8 sq. ft.
Aggregate surface	517.7 sq. ft.
Engine weight, empty	16.3 metric tons
Engine weight, loaded	18.2 metric tons
Car.	
Wheel diameter	39 ins.
Wheel base (motor bogie)	9 ft. ¾-in.
Wheel base (coach)	8 ft. 2 ins.
Total wheel base	51 ft. 6 ins.
Minimum curve radius	600 ft.
Total length of car	78 ft. 7 ins.
Greatest breadth	9 ft. 6 ins.
Greatest Height	14 ft. 9 ins.
Motor car weight, empty	45.9 metric tons
Motor car weight, in working order	51.5 metric tons
Trailing car weight	40 metric tons

The engine was built by J. A. Maffei, of Munich, and the coach proper by the firms: Vereinigten Maschinenfabrik, Augsburg, and Maschinenbaugesellschaft, of Nürnberg. We are indebted for our description and illustrations to "The Engineer," London.

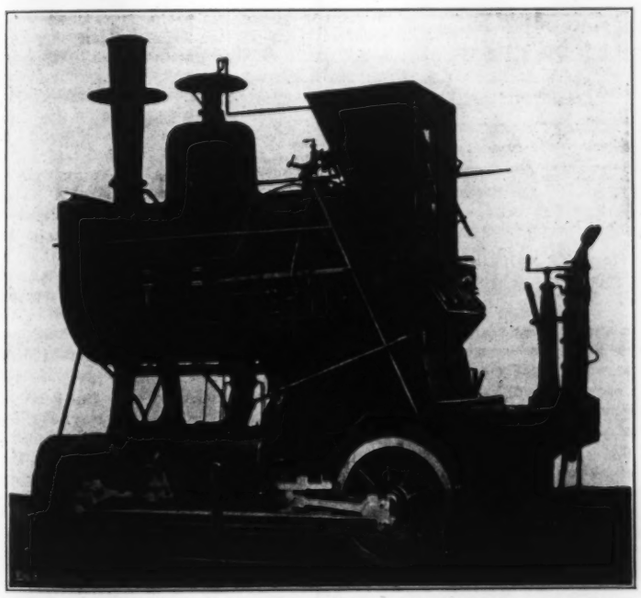


FIG. 1. ENGINE USED IN THE RAILWAY MOTOR COACH SHOWN IN FIG. 2.

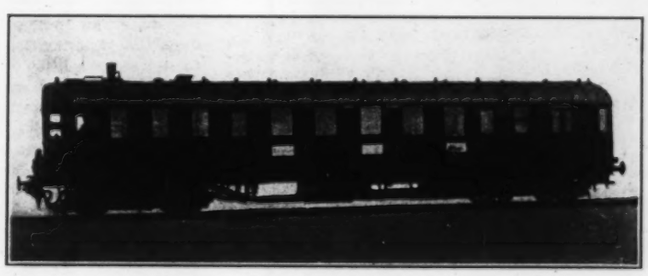


FIG. 2. RAILWAY MOTOR COACH BUILT FOR THE BAVARIAN STATE RAILWAYS.

A BUTTING COLLISION occurred between two passenger trains on the Long Island R. R. at Dunton, a way-station just west of Jamaica, L. I., Nov. 9, during the rush hour. All the cars of both trains, except one parlor car, were either telescoped or smashed, but none of the 300 passengers were killed, and only five injured, none seriously. The cause of the wreck was an open switch, which carried the west bound train over on to the east bound track, the speed making it impossible to stop the trains in time to avoid the collision.

SMOKE ABATEMENT IN ST. LOUIS, MO.*

For the information of those interested in Smoke Abatement, I desire to state that at the present time this city has 983 manufacturing concerns and other plants that are using smoke-consuming devices, the character of which is as follows: 550 steam jet and air blast; 264 down draft furnaces; 50 fire brick arches; 19 automatic stokers; 74 have changed to electric power; 26 burning smokeless fuel.

These plants contain from 1 to 30 boilers each. We also have about 230 heating plants, which contain low pressure boilers or furnaces, used for heating purposes entirely, and to which plants mechanical smoke-consuming devices cannot be applied.

A large majority of plants in the city are complying with the law by the proper use of devices installed, in connection with competent stoking. It has been the experience of this department that oftentimes firemen are responsible for smoking chimneys, by the failure to properly use the device in connection with proper stoking, which has been the cause in a great many instances of this department prosecuting the owner or manager of a concern. A modern and good smoke consumer is worthless if it is not handled intelligently by the fireman, and it is also a fact that firemen do not take kindly to new ideas which exact care or compel labor beyond the routine measure. There is, therefore, with this condition existing only one way to overcome the difficulty, and that is to license the firemen.

The smokeless condition of Berlin is ascribed to three facts, and until this city follows similar lines there will always be some smoke. Berlin's cleanly condition is due to the preponderant use of smokeless fuel, in the form of coke and briquettes, the skillful, scientific construction of boiler furnaces and chimneys, and finally a high standard of skill is taught and enforced among firemen who stoke furnaces with coal for steam and other purposes. It is a matter of record in Berlin that before a man can assume such a charge he must be taught the theory and practice of economical, scientific firing; in other words, to secure perfect combustion of the volatile elements of coal. A law of this sort is badly needed at the present time here.

Another of the chief difficulties experienced by this department in the way of smoke abatement arises from plants that have insufficient boiler capacity. In this connection I believe that an ordinance requiring the installation of sufficient boilers in a plant, to avoid the necessity of crowding or overworking them, and regulating the amount of space to be devoted to boiler and engine rooms, plans for same to be approved by proper city officials, would tend greatly to assist in smoke abatement, as from experience there is great difficulty in abating dense smoke where such conditions exist. Since this department was created a great number of plants where crowding was being done have installed additional boilers, and are at the present time making satisfactory smoke records.

The smoke remaining as yet in the atmosphere of this city is due to:

(1) Railroads, brick kilns and blast furnaces, with which the town is practically surrounded.

(2) Heating plants and private residences.

(3) That remaining from manufacturing plants, by the improper use of devices, and careless stoking.

(4) East St. Louis.

From personal investigation and reports from other cities, the question of smoke from locomotives carrying a heavy load is still unsolved, but by proper stoking a large percentage of the smoke can be overcome. The question of smoke from brick kilns and blast furnaces is still a matter of study, and at present there is no known smoke device that can be used in this connection. Careful stoking in both cases by experienced hands will tend to lessen this evil.

As there is no mechanical device that will operate on the majority of low pressure boilers, in order to obviate

*A statement issued by the Smoke Abatement Department of St. Louis, Oct. 29, 1906; C. H. Jones, Chief Inspector.

the smoke from this source it is necessary that proper firing be done, where soft coal is used, good results having been obtained by following these instructions:

(1) Fire frequently, in small quantities and at regular intervals.

(2) Break up the lumps to fist size.

(3) Carry a level furnace over entire grate.

(4) Avoid thin or bare spots on grate.

(5) Keep the fires clean.

(6) Fire one door at a time, and wait until that fire is in good shape before charging the other door.

(7) Leave furnace door slightly ajar one minute after each firing.

In almost every instance these instructions are violated in low pressure plants, and when the smoke inspector turns his back the same condition exists, dense smoke being emitted in great quantity, resulting in prosecution. These plants as a rule are handled by janitors or others that do not understand the workings of a furnace.

The smoke arising from tens of thousands of private residences during the fall and winter months, when atmospheric conditions are not perfect, is sufficient to cover the entire city.

The manufacturing plants of the city in the majority of cases can make satisfactory smoke records, where the device is handled intelligently and proper stoking is done, but in numerous instances incompetence or neglect in the boiler room tends to cause the owner or manager endless trouble with this department, whereas, if the subject had been studied, careful and competent men employed, the condition would be reversed.

The matter of smoke from East St. Louis, as observed by this department, when the wind is in the east, is sufficient to cover the downtown district as far west as Twelfth St., and one has only to glance across the river to satisfy himself of this condition.

A diary kept in this office, showing the smoke conditions of every day in the year, will reveal that this city with what has already been done is greatly improved; in fact, from January 1, 1906, to present date there were few smoky days. These were as follows: Wednesday, January 24, east wind; Friday, March 2, raining and dark; Wednesday, March 7, dark between eleven and twelve o'clock, noon; Friday, March 23, cloudy and east wind. The atmosphere of the days in question was full of moisture and foggy. At the time this department was created conditions such as existed on the days mentioned were almost of daily occurrence, regardless of the condition of the atmosphere.

This department has prosecuted 231 violations of the law, but court procedure was not resorted to until every effort had been exhausted to avoid same.

In many instances, with certain plants of the city, changes were being made as fast as possible, for say a year, and oftentimes longer before good smoke results were secured, and these conditions being known by this department, and that every effort was being made to comply with the law, it would be useless to prosecute, as no intelligent jury would convict a party where men were working in the boiler room to remedy the situation and disposition was shown to comply with the law.

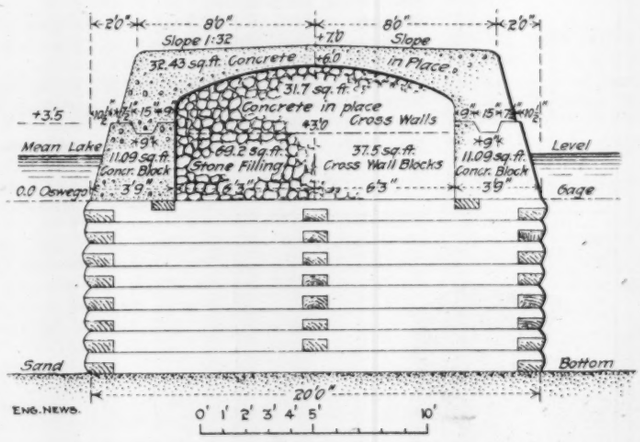
THE NEW GENERATING STATION for supplying electricity to the street railway system owned and operated by the London County Council, of England, has recently been put in operation. When extended to its full proposed size this station will have a capacity of 34,000 KW. and will have cost about $4,500,000. Only half of it is now completed and equipped, the other half being under construction. That portion of the station now in operation contains 24 water-tube boilers and 4 generating units driven by reciprocating engines. The boilers carry a working pressure of 200 lbs., and are fitted with chain grate stokers. The steam is superheated to a temperature of about 500° F. Condensers of the surface type, with separate motor-driven air pumps, are used. Each generator is driven by a pair of horizontal-vertical engines, one on each side. The engines run at 94 r. p. m. and work at 180 lbs. steam pressure. The generators are of the revolving field type, direct connected, and deliver three-phase current at 6,600 volts and at 25 cycles per second. The normal output of each is 3,500 KW., or 306 amperes, per phase, and 4,375 KW. on emergency overload. The switch gear is of the oil-break, remote-control, electrically-operated type. The feeders leave the station in two groups by means of two separate tunnels, one tunnel carrying the cables for supplying the north of London and the other carrying the cables for the south of London. Three motor-generators of 500 KW. each, running at 300 r. p. m., and transforming the 6,600-volt three-phase current to direct current at 550 volts pressure, are located in a recess adjoining the switchboard. This sub-station comprises also a battery of 280 accumulator cells in the basement, and supplies current to the local street railway lines and for station purposes. The generating station, when completed, will contain 48 boilers and 8 generating units. It is proposed to use steam turbines with generators of 5,000-KW. capacity in the remaining portion of the plant.

COST OF CONCRETE SUPERSTRUCTURE, WEST PIER, CHARLOTTE HARBOR, N. Y.

The early harbors on Lakes Erie and Ontario were formed by the construction of parallel piers at the mouths of the larger streams, dependence being placed on floods to scour out the contracted channel between them. A typical lake harbor of this kind is that of Charlotte, N. Y., on Lake Ontario. This harbor is at the mouth of the Genesee River, about six miles north of Rochester, N. Y.

The first project to build a harbor here dates back to 1829, when the construction of parallel piers was begun, the object being to secure a channel 12 ft. deep across the bar at the mouth of the river, the depth of which at the time was 8 ft. These piers have gradually been extended and have now reached a present length of about one-half mile each, lighthouses being located at the outer ends. The distance between the two piers is 450 ft. The amount expended on this harbor to June 30, 1905, was $588,085.

The piers (as elsewhere) were built of timber cribwork, filled with stone, both below and above water. Owing to the perishable nature of timber, the superstructure or portion above water was short-lived and subject to many repairs and renewals. The action of the sand under water upon the joints of the timber work greatly added to its deterioration. In order to avoid these constant repairs, it was concluded to replace part of the timber superstructure of the pier with imperishable materials.



CONCRETE SUPERSTRUCTURE ON WEST PIER OF CHARLOTTE HARBOR, N. Y., AS SUBSTITUTED FOR CRIB-WORK IN 1903.

The accompanying section shows the adopted design, which consists of semi-submerged concrete blocks resting upon the timber cribs. The space between the blocks is filled with rubble stone, which is carried to a height of 6 ft. at the center, above the crib level. A concrete deck, resting at the sides upon the concrete blocks, and also covering the rubble stone filling, completes the structure. Cross walls, built at certain intervals, tie the structure together.

During the season of 1903, 301.5 ft. of the old decayed superstructure of the west pier was rebuilt with concrete, the work being done by the U. S. Government, by day labor. The cost of the work is given in the report of the Chief of Engineers, U. S. Army, for the year ended June 30, 1904. As there is a likelihood that more or less work of this nature will be done in the future at various harbors on Lake Ontario, it may be of interest to contractors to know what the work at Charlotte has cost, and we therefore give a synopsis of the operations there, as reported.

The preparatory work consisted in putting up complete a derrick scow for handling concrete blocks weighing nine tons, making and setting up 13 molds for the concrete blocks, installing a concrete mixer on a scow and loading on scows at Little Sodus Bay 156 cu. yds. of beach gravel and sand for making concrete.

The work of tearing out the old decayed superstructure was begun Aug. 4, 1903, about 6 ft. inshore of the lake shore line and then worked lakeward. As the tearing out advanced the work of leveling and repairing the timber crib substructure at the level of low water was carried on. This work was greatly retarded by the high stage of water and the muddy condition of the water, which made it impossible to see the work two or more feet under water, and required the employment of divers to fit and fasten and level most of the timbers put in to form the required bearing surface for the concrete blocks. The crib substructure was found to be of poor construction (it was built in 1829-1834), necessitating much unlooked-for repair work. In the case of two cribs, 30 ft. long each, it was necessary to remove the harbor walls to a depth of 5 to 7 ft. below the water and build and set in place new cribwork.

When the inner end of the superstructure was removed much trouble was also caused by sand being thrown in by waves over the newly prepared foundation, requiring repeated cleaning off of sand before the concrete blocks could be set in place. The making of concrete blocks, setting them in place, replacing the stone filling and making the concrete deck over the blocks and stone filling was carried on as the foundation work progressed.

All of the concrete blocks and concrete in place were made of 1 part Lehigh Portland cement, 2½ parts sand and 6½ parts beach gravel and stone. This beach gravel and stone was found by test to be quite uniform in size; the 2 parts of gravel passed through a ¼-in. screen and were caught on a 1-in. screen; the 4½ parts of stone ranged from 1 in. to 2 ins. in diameter. The concrete was found by test of two blocks of 1 cu. ft. each to weigh 153 lbs. per cu. ft.

The concrete superstructure over the length of pier of 301.5 ft. was completed on Nov. 27, 1903, at a total cost for labor and materials, repairs to plant, etc., but exclusive of the cost of concrete mixer and derrick and derrick machinery, of $12,663, or $42 per lin. ft. This cost is itemized as follows:

Removing old superstructure and leveling and repairing crib substructure, per lin. ft. $19.28...	$5,813
Concrete blocks, making and placing, 56 blocks, 248.2 cu. yds., $12.30 per cu. yd	3,052
Replacing stone filling between blocks, and incidentals	597
Concrete in place, including making and placing forms, manhole covers, 427.8 cu. yds., $7.48 per cu. yd.	3,202
	$12,664

Another section of the west pier was reconstructed during the season of 1904, the work being started July 6, 1904, and continued until Nov. 30, 1904, at which time 316 lin. ft. were practically completed.

The following amount of concrete was placed:

	Cu. yds.
66 face-wall blocks.....	560.37
26 cross-wall blocks	88.85
Total blocks	649.22
11 sections of deck, mass concrete.....	2,087
Total	2,736.307

The total cost of the concrete was $6,1[illegible], or $7.85 per cu. yd., and of the whole work of reconstruction, $18,530, or $52.28 per lin. ft.

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The coroner's jury on the Atlantic City drawbridge disaster, after a week of investigation in which the facts in the case were clearly brought out, brought in a verdict placing the responsibility upon the bridge tender for the 57 lives lost because he failed to make sure that all the rails were down in place before giving a clear signal to the towerman who operated the semaphores. They added the following recommendation:

> We strongly recommend that the men employed to operate the drawbridge inspect both ends of the draw before the signal is given for trains to pass the opening ends of the draw.

There could not possibly be a better illustration of the hopeless inadequacy of the antiquated coroner's jury investigation to protect the public from the manifold dangers which in our complex modern civilization lurk at every hand. Here was an accident whose causes were so clear that it seemed impossible for any man of ordinary intelligence to fail to perceive them or to misconstrue the lessons to be drawn, notwithstanding the endeavor to shroud all the circumstances in mystery. Yet a coroner's jury, apparently made up of an unusually high class of men, returns a verdict placing the responsibility for the loss of 57 lives upon a drawbridge tender! If this verdict were a sound one, then the safety of the passengers on every railway is dependent on the faithfulness of the inspection of the drawbridge tenders at every crossing of a navigable stream! To state such a proposition to an engineer is enough to prove its absurdity; yet one of the foremost metropolitan dailies in commenting editorially on the Atlantic City verdict, suggests in apparent good faith that at every drawbridge trains should come to a stop and the bridge tender himself should get on and ride across on the train to which he has given a safety signal!

We pointed out with sufficient fulness last week the real lessons of the Atlantic City disaster; but this absurd verdict of the coroner's jury ought to call renewed attention to the crying need for the investigation of railway accidents by Government experts, to the end that needed reforms in practice may be brought about. Something of this sort has at times been attempted by some of the State railway commissions, notably those of New York and Massachusetts; but the semi-political character of these commissions, their brief tenure of office, and their inability to secure and retain permanently in their service a high class of expert investigators makes it evident that little is to be hoped for in this direction.

The most promising direction in which to look for better things appears to be the Interstate Commerce Commission. That body is now doing excellent work in the collection of railway accident statistics, and in its quarterly reports it presents comments on some of the accidents most serious in their results. These comments, however, wholly omit the name of the road, the place of the accident and everything which could identify it, and the comment is prepared, moreover, on the basis of the information which the railway company itself furnishes.

It is manifest that such emasculated reports are of little influence in reforming railway practice. What is wanted is a thorough technical investigation made by a permanently employed staff of competent experts, able to report without fear or favor, to place responsibility just where it belongs and to condemn methods and appliances which are shown by experience to be defective. Such investigations and reports on railway accident have been made in Great Britain for many years by officers of the Royal Engineers, acting under direction of the Board of Trade, and have had a most important effect in the improvement of railway practice and reducing the risk of railway travel.

We presume if legislation were brought forward in Congress to enable the Interstate Commerce Commission to conduct such expert investigations of railway accidents, all the railway lobbies and lobbyists at Washington would unite their efforts to defeat it. Actually, however, there can be no doubt that such investigations would be to the benefit of the railway companies.

Nothing is of greater consequence to the railways than the adoption of safe methods and appliances. It is by accidents and disasters that defects in practice are made evident. The disciplinary value of a serious accident on the whole operating force, from the general manager down to the trackmen, ought not to be lost. One company ought to be able to learn from the experience of another.

All these things are self-evident; but under the present practice of covering up and hushing up everything in connection with an accident, all these benefits that ought to accrue are wholly lost.

It may be said that the railways make their own investigations of these accidents; but how much do such investigations amount to? Actually they amount to nothing more than a basis for disciplining the employees especially concerned. The fact is that the operating officers have no time to make a really thorough technical investigation of important accidents, and only an exceptional few are competent to make one. When a wreck occurs, the time of the officers is taken up in clearing the line, repairing damage, getting traffic moving, settling claims, warding off newspaper reporters, etc. No one has any time to really study the disaster itself to the end that its technical lessons may be learned. Doubtless a few officers manage to get a clear idea of the actual facts; but according to universal custom, whatever they may learn is kept locked in their breasts as a profound secret.

Against this long standing custom we desire to register emphatic protest. We believe it would pay—and pay many times over—any one of our great railway companies to employ a special expert at high salary solely for the investigation of accidents, with authority to make the results of his investigations public for the instruction of the entire operating force. We can, of course, see the difficulties in the path of such an expert investigator, whose report might reflect on the general manager or other high official; but the advantages are none the less certain.

Viewed from this standpoint, it ought to be clear that Government investigation of railway accidents would be beneficial to the railway companies; and there is no good reason why they should oppose it.

We reprinted last week from our issue of Feb. 12, 1887, the drawing of the Childs-Latimer bridge guard which was then standard on the New York, Ontario & Western R. R. We have since learned that this bridge guard is still the standard on that road. The experience of a score of years has developed nothing any better, and nothing to lead the management to doubt the efficiency, safety and general merit of this type of bridge floor and approach construction. Doubtless there are many other railways where similar guards are in use with equal satisfaction. Some of these are mentioned in our column of "Letters to the Editor" this week.

We desire at this time also to call attention to the inside guard rails on the Thebes bridge over the Mississippi River, illustrated in our issue of May 11, 1905. Here heavy angle irons with the flange turned toward the center of the track are used for inside guard rails. They have the advantage that a derailed wheel will not snap off the spike heads, as may happen with ordinary rails used as guard rails, and it is also more difficult for a wheel to climb them.

Evidence multiplies that typhoid fever is much more prevalent this year than last in many sections of the country, and therefore that the Washington filtration plant may have saved many deaths from typhoid fever in the District of Columbia this year, even though the rate for 1906 proves to be a little higher than that for 1905. Mr. Horton, in his special report on typhoid fever in Washington, which we published last week, showed that typhoid in a number of Southern cities was considerably higher just now than in 1905. The Boston "Medical and Surgical Journal" of Nov. 1, 1906, states that

> since last July it is reported that about 100 cities and towns have been visited by the disease, and very recently it was estimated that there were approximately 1,000 cases in the State. Many cities and towns about Boston have reported outbreaks, but cases are also reported from more distant places, as, for example, North Adams, Northampton, Provincetown, Springfield and Westfield.

The same authority also states that of some 270 medical patients at the Boston City Hospital, at least 50% during September and October were suffering from typhoid.

The October Bulletin of the New York State Department of Health shows that for the whole State there were 222 deaths from typhoid fever in September, 1906, as compared with an average of 183 for the Septembers of the past five years and 178 in September of 1905. In some of the sanitary districts into which the State is divided for summarizing vital statistics, the prevalence of typhoid in September of this year is even more marked than is indicated by the figures just cited. In the Adirondack and Northern District, which includes Watertown, Ogdensburg, Plattsburg, Sandy Hill and smaller places, there were 21 deaths from typhoid in September of this year, as compared with only 9 for September, 1905. It is particularly interesting to note that Watertown, with a population of about 25,000, had 5 of the 21 typhoid deaths in its district in September of this year, or nearly one-fourth of the total in the district, comprising a population of 408,000. Watertown, like Washington, has a filtration plant which was installed largely on account of previous high typhoid in that city.

Chicago, which, relatively speaking, has been remarkably free from typhoid for many years past and which is still suffering but little from the disease, shows 301 deaths from typhoid for the first ten months of this year, as compared with 268 for the corresponding period in 1905. During October, 335 Widal tests (to aid in the diagnosis of typhoid) were made in Chicago, of which 106 were positive, as compared with the total of 198 tests in October, 1905, of which 75 were positive.

As bearing upon the assertions that other causes than the water supply are responsible for the prevalence of typhoid fever in Washington, and particularly that the milk supply must come in for its share of blame, it may be noted that the last annual report of the Massachusetts State Board of Health cites a number of outbreaks of typhoid in that State which have been traced

to dairies connected with which was some one who had recently suffered from typhoid fever.

It is sincerely to be hoped that more and more attention will be directed to milk supplies and other causes than water for the spread of typhoid, thus relieving water departments of any burden that does not belong to them and, of more importance, aiding in the reduction of typhoid to a reasonable figure—if there be such.

An interesting situation has arisen in New York City. A corporation which erected a marble-front business building on Fifth Avenue in such a way as to project parts of the building several feet out upon the sidewalk has been declared by a justice of the State Supreme Court to be illegally occupying public ground. Now the city's legal representative, Corporation Counsel Ellison, is preparing to proceed against other owners along Fifth Avenue who have projected their buildings, porticos, lawns, dining piazzas, etc., over the building line. Thus, if we are fortunate to live long enough, we may see a fight to regain for the use of the public a large area of public street long devoted to exclusively private uses. And this fight will be in a city where the aggregate amount of encroachment of private interests upon public thoroughfares is simply appalling in magnitude; a city where a few years ago the attempt of a courageous Police Commissioner to prevent store-keepers and shippers in certain busy downtown streets from continuously blocking the sidewalk by loading-skids and the like was thwarted within a week.

Unfortunately the daily press of the city is not single-voiced in upholding the proposed reformation. Some journals of very self-conscious virtue speak of the movement in deprecatory tone, hope the city will not act rashly, trust that higher courts will reverse the decision of the single judge, and suggest that the proposed action is unnecessary because equivalent relief to traffic could be obtained by keeping heavy trucking off Fifth Avenue during certain hours. These newspapers appear to be wholly blind to the principle involved: that the conversion of public property to private use is "grafting" pure and simple, and therefore criminally offensive to public policy. We mention this aspect of the matter because it is perhaps too much to expect newspapers to recognize that the encroachment graft does heavy injury to the city's progress, and that its correction must promote the welfare of the community in the long run.

Engineers more than other men are vitally concerned in this subject of encroachment on public property, for two main reasons. In the first place, it is engineering activity that is called upon to provide the solution of the difficult transportation problems in cities, and these problems are in measurable degree complicated and aggravated by private encroachments on public thoroughfares. In the second place, a large part of the blame for progressive encroachment rests on the shoulders of the engineer's half-brother, the architect, with whom the engineer cooperates in many phases of work; and, since architects as a class show little appreciation of the seriousness of their sins against the "building line," it is doubly important that engineers should, individually and as a class, stand emphatically against the continuance or further progress of street encroachment. The mere private citizen, as a property-holding animal, has no conscience whatever in the matter, so that no improvement is to be looked for from the action of self-interest.

Information that is almost (but not quite) startling is contained in the latest issue of our British contemporary, "Concrete and Constructional Engineering." A picture is there published which shows some old wooden piles that appear gnawed nearly through at the bottom as if by an industrious colony of beavers. The caption under the cut, and a paragraph of accompanying text, inform the reader that this destruction was wrought by the "Toledo," and the article then refers to the economy of reinforced-concrete piles, which, being proof against the action of the "Toledo," are to be used in some pile replacement in Newhaven harbor. Though we have no other information about the pile-eater referred to, we venture to suggest that in analogy to the name of the well-known "ship-worm" *Teredo navalis* we should call this beast the *Toledo novel is.*

FORMULAS FOR COMPUTING THE COST OF IMPURE WATER SUPPLIES.

The value of an ample public supply of pure water to a community is often talked of but seldom appreciated. A full appreciation of its value requires a high degree of intelligence, including technical knowledge, and no little imagination. The latter quality is demanded because impure water is responsible for a host of ills and evils, including physical suffering and mental anguish, that have no means of representation except in terms of the imagination. But there are a number of elements in the value of pure water that can be expressed more or less readily and accurately (or perhaps we should say approximately) in terms of dollars and cents. By far the most important of these, although not admitting of very close valuation, is the sanitary quality of water, as indicated by typhoid and other mortality. Next in the economic scale, and perhaps capable of more exact expression, are hardness and turbidity, sometimes one and sometimes the other ranking first in local importance. Odor and color are elusive qualities, so far as valuation is concerned. Although nothing will cause so complete and violent a popular protest against a public water supply as bad odor, yet aside from its unpleasantness it is of little moment. Objection to color depends much upon the degree of color to which a given person or community is accustomed, as is also largely but not so largely true of turbidity. Odor and color can be valued only as they affect the attractiveness of water. The same measure must be used, to some extent, for turbidity, but in addition turbidity may be a nuisance, if not worse, through the deposition of sediment, which interferes with industrial processes. To a lesser degree, both color and odor might lessen the value of water for industrial uses.

There have been frequent attempts to express the value of pure water in dollars by computing the value of the lives sacrificed through typhoid fever caused by polluted water supplies, at the same time making an allowance for medical and other expenses incurred in behalf of typhoid patients who recover. In a recent paper on "The Value of Pure Water,"* Mr. George C. Whipple,† Assoc. M. Am. Soc. C. E., has presented a series of formulas for computing in terms of dollars per 1,000,000 gals. of water consumption, the cost or "depreciation" due to sewage pollution, turbidity, color, odor and hardness in water, and to these he has added a formula for "depreciation due to temperature." The formulas are supported by explanations and illustrations and are supplemented by tables of values per 1,000,000 gals. for different rates of preventable typhoid death rates, turbidity, etc. Both for practical usefulness and for its many lines of suggestions the paper is a notable one and deserves, as it will doubtless receive, the careful attention of engineers and sanitarians. It also deserves, but is less likely to receive, the consideration of municipal officials generally. We present below the formulas and some of the supporting statements, with a few comments of our own, and commend the full paper to all who desire further details.

Before giving the formulas it should be noted that the author has not attempted to do more than indicate the value of pure water to domestic consumers, save that "pure" here embraces practically all objectionable qualities of fairly common occurrence, including even temperatures unpleasantly high for drinking water. This, we think, is a proper use of the term "pure," since it makes for simplicity and, although not strictly accurate, is in accordance with the general conception of what public water supply should be.

The formulas presented by Mr. Whipple are as follows:

Depreciation due to sanitary quality: $D = 2.7 \ldots N$.

Depreciation due to physical characteristics:

$$D = 20 \frac{p_c + p_t + p_o}{100}$$

$$p_c = \frac{c}{2}$$

$$p_t = 5\sqrt{t}$$

$$p_o = 2\,O^2_v + 3.5\,O^2_d + 5\,O^2_o.$$

Depreciation due to hardness: $D = \frac{H}{10}$.

Depreciation due to temperature: $D = \frac{(d - 45)^2}{\ldots}$.

in which

D = the depreciation value in dollars per 1,000,000 gals. [assuming a per capita consumption of 100 gals. daily. If the consumption is more or less a correction must be made.—Ed.];

T = typhoid fever death-rate per 100,000;

N = typhoid fever death-rate assumed to be due to causes other than water, and which may be ordinarily taken as 20 per 100,000;

p_c, p_t and p_o = per cent. of consumers who object to the color, turbidity and odor, respectively, of the water;

c = color reading;

t = turbidity reading;

O_v O_d and O_o = odors due to vegetable matter, decomposition and microscopic organisms, respectively, expressed according to standard numerical scale;

H = hardness of water in parts per 1,000,000;

d = average temperature of water during four warmest months.

The term "depreciation" does not seem to us satisfactory, since the values to be found by the formulas are not based on the actual values of the waters to which they apply. In the formulas for sanitary quality and hardness the values sought are actual costs and in the other formulas either actual costs or else the costs that would be incurred if "objecting consumers" substituted spring water for the portion of the public supply that is used for drinking water. Moreover, depreciation involves a lessening of quality or value, and many public water supplies now in use always had the objectionable or dangerous qualities that they now possess, in which case depreciation values could be expressed only in relation to the values of ideal supplies. It therefore seems to us that "cost" would be a better term than "depreciation." If a term with a meaning in some respects similar to depreciation be insisted on, then damages might perhaps be used, although like depreciation the word conveys a wrong idea of the nature of the values to be expressed.

If in place of "depreciation" the term "cost" be used, and in fact whether the substitution be made or not, we venture to suggest that the title of Mr. Whipple's paper might better have been "The Cost of Impure Water." Accordingly, we have expressed that idea in the title of this discussion.

A few words may now be said regarding some of Mr. Whipple's formulas. The first one, relating to sanitary quality, or, more forcibly put, sewage pollution, is based on the money value of the lives lost through typhoid fever due to polluted water, with an allowance for sickness expenses of typhoid cases that recover and also an allowance for other deaths than typhoid due to impure water. The total unit allowance is $10,000 for each typhoid death in excess of what may be termed a normal typhoid death rate if deaths due to other causes than the public water supply were eliminated. This normal rate (N in the formula) may vary from 15 to 25, and must be determined for each community separately, in accordance with local conditions. In the absence of local knowledge, 20 per 100,000 may be assumed. The $10,000 named is divided as follows: $5,000 per typhoid death above the normal; $100 each for ten cases of typhoid sickness to each death; $4,000 for other deaths and sickness due to bad water for each typhoid death above the normal. All things considered, we believe $10,000 is a reasonable allowance for the purpose named. Capitalized at 4%, this loss would warrant a cash outlay of $250,000 for its prevention, but 4% would cover interest charges only, whereas depreciation on plant and cost of operation (for filters, for instance) should also be taken into account. At as high a total rate

*Reprinted from "Biological Studies by the Pupils of William Thompson Sedgwick" (Chicago, 1906).

†Of Hazen & Whipple, Consulting Engineers, 220 Broadway, New York City.

as 15% a capital outlay of $67,000, with necessary allowances for operation, would be justified to prevent one death a year from water-borne typhoid and associated ills.

To take a concrete case: The city of Burlington, Vt., with a population of about 20,000 and a recent average of about five typhoid deaths per year, or a rate of 25 per 100,000, might well afford to spend $60,000 to $70,000 for filters, if by doing so it could cut its typhoid deaths down by an average of one a year, or to 20 per 100,000. The probabilities are that a pure water supply at Burlington would effect a greater reduction than this in the typhoid death rate, and that it would also effect more of saving in other sickness and death than allowed for by Mr. Whipple, since Burlington has an unusually high mortality from diarrheal diseases and also an abnormal total mortality.* It should be noted that other savings than those due to reduced typhoid and related diseases would be effected at Burlington by the introduction of filtered water, according to Mr. Whipple's formula; but they would be small in comparison, since aside from sewage pollution the Lake Champlain water is generally acceptable to the people of that city.

The formula for determining the cost of unfavorable physical characteristics of water, as might be expected from the nature of the problem, is the most complicated in origin, and, it appears to us, the most uncertain in result of the four. It is founded on the percentage of consumers who object to color, turbidity and odor, and in so far as it has any statistical basis rests on canvasses of two or possibly more groups of individuals in the East and in the West. In other words, its basis is psychological, and limited at that. Nevertheless, the attempt to evolve the formula is creditable, the method ingenious and the result, as checked by application to known conditions, and when compared with the cost values given by the other formulas, generally reasonable.

As to the hardness and temperature formulas, it may be explained that the first is based on the amount of soap required to neutralize hardness used for bathing purposes and the second on the amount of ice required to reduce the temperature of drinking water to 45° F. during the summer months; in the temperature formula the percentage of objecting consumers is also taken into account.

As has been said, Mr. Whipple gives tables for the values of D in the various formulas. Instead of one table for physical characteristics he gives separate tables for turbidity, color and odor. As a matter of interest, and to illustrate, although somewhat unfairly, the relative values of the different damaging qualities of water, we give the values midway in the range shown in each table: for example, the range of preventable typhoid is 1 to 150, and we give the sanitary cost per 1,000,000 gals. of water consumed where the preventable typhoid is 75 deaths per 100,000 population. This and the other figures are as follows:

	Rate.	Cost.
Sanitary	75	$216
Turbidity	500	112
Color	100	50
Odor	Half-way between faint and distinct.	19
Temperature	67° F. ±	3*
Total		$450

*About midway in money cost, instead of in range.

The total cost of damaging or unattractive qualities to the extent indicated, it is seen, is $450 per 1,000,000 gals. of water consumed, or 45 cts. per 1,000 gals., assuming that the water consumption is 100 gals. per capita per day. This comparative summary, as has been said, is not perfectly fair, or perhaps one should say exact, because each and all of the qualities would never, in practice, fall just midway in the several ranges of value. It is conceivable, however, that the most weighty factors in the total cost given might so fall, but color would seldom and odor rarely accompany high turbidity. The total cost of dangerous and objectionable water to a community does sometimes far exceed $450 per 1,000,000 gals., on the basis of Mr. Whipple's formulas. For instance, he cites a reduction of typhoid fever at Lawrence, Mass., from 121 to 26 since filtration was adopted. This would correspond to $261.25 per 1,000,000 gals. of water consumed were the rate 100 gals. per capita, but at the actual rate of 40 gals. it figures out $653, and this is for typhoid alone. Such figures afford concrete evidence of the inappropriateness of using the term "depreciation" to express the losses due to impure water.

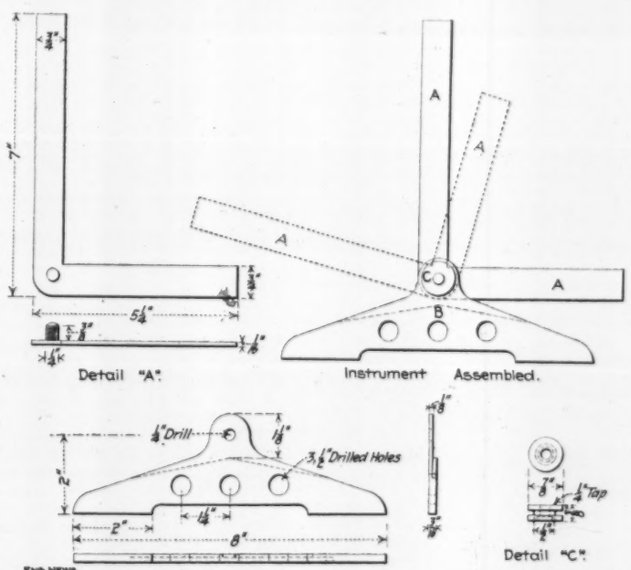
We are aware that in so brief a compass we have been unable to do more than call attention to the main features of Mr. Whipple's valuable paper, but we trust that what has been said will lead many to secure the original and to apply it to water supply conditions for which they are responsible or, whether responsible or not, may in some measure affect for the better.

*See "Water Supply, Typhoid Fever, Diarrheal Diseases and Infant Mortality at Burlington, Vt., 1879 to 1905, Inclusive," by M. N. Baker, Journal New England Water-Works Association, Vol. XX., No. 2. Since this article was written the voters of Burlington have authorized the city council to issue $75,000 of 4% bonds for the filtration and improvement of the water supply.

LETTERS TO THE EDITOR.

A Handy Drafting Instrument.

Sir: Enclosed find a print of a very handy instrument for a draftsman. The instrument can be made in a machine shop in a short time. The part A is of sheet steel about 1/16-in. thick, and B is about 3/16-in. thick; C is a thumb screw. The lower part of B rests against



DETAILS OF A HANDY DRAFTING INSTRUMENT FOR USE WITH A T-SQUARE.

the T-square. When the instrument is set to any angle, you have a right-angle at the same time, useful for drawing threads, section lining, or anything that requires an odd degree.

Hoping you may find this valuable to your readers,

Respectfully,

Arthur McAlpine.

86½ Owasco St., Auburn, N. Y., Oct. 26, 1906.

Directions for Making Rust Joints.

Sir: Will you kindly give through the columns of your paper directions for making rust joints between concrete foundations and engine beds.

Yours sincerely,

W. H. Himes.

Lansing, Mich., Oct. 23, 1906.

[For a quick setting, rust-joint cement use 1 part powdered sal ammoniac, 2 parts flour of sulphur, 80 parts iron borings, all by weight, and mix to a paste with water. For a slow setting, rust-joint cement use 2 parts powdered sal ammoniac, 1 part flour of sulphur, and 200 parts iron borings, all by weight. The latter cement is considered preferable to the former if the joint is not to be used immediately. The recipes given are taken from "Molesworth's Pocket Book of Engineering Formulae."—Ed.]

The Amount of Water Used in Fighting Fires.

Sir: Many readers of the News will recall the fire that occurred in Atlantic City on April 3, 1902, which swept away the Luray and Berkley Hotels, besides several smaller structures, jumped across the Boardwalk, ignited Young's Pier and burnt that in two. In connection with the recent discussion (Eng. News, Sept. 13, Oct. 11 and 25, 1906) concerning the small amount of water used in extinguishing large fires, the following notes, relating to the Atlantic City fire, may be of interest:

The fire started at 10 a. m. and was under control by 3.15 p. m. Including three steamers from Philadelphia and two from Camden, there were 16, furnishing 23 streams; making, with those from hydrants, about 30 streams in use during the height of the conflagration. The total pumpage from noon, April 2, till noon, April 4, was 9,318,290 gals (nearly all of this was measured by a Venturi meter), which was but 2,875,119 gals. above that pumped during the 24 hours preceding and the 24 hours succeeding this period; 2,900,000 gals. may therefore be taken as the approximate volume of water consumed in putting out the fire.

Yours truly, Kenneth Allen.

Ingram Building, Baltimore, Md., Nov. 3, 1906.

Concerning Failures of Reinforced Concrete Structures.

Sir: I see by this morning's N. Y. "Herald" that another has been added to the already too long list of reinforced concrete structures that have failed. Is it not high time that the attention of architects and owners was called to the necessity of employing expert engineers to design this kind of work and not trust to the contractor to provide sufficient strength.

What would be thought of an architect who merely specified for a steel frame building, that the contractor shall put in as much steel as he thinks necessary? And yet this is precisely what is generally done with reinforced concrete construction; and it is very much more dangerous with reinforced concrete to allow such latitude to the contractor, because there are a great many patent constructions, whose designers have a very erroneous opinion of the strength of materials, whereas in ordinary steel frames the permissible stresses are well established.

There are now so many engineers who are well qualified to design reinforced concrete work, and there is so little uncertainty about the stresses of the composite material, that no excuse exists for the use of arbitrary formulas put forth by the inventor of some patent design of reinforcing steel.

It matters very little in what form the steel is used if it is of proper quantity, and placed where it is needed. Further, no failures due to green concrete would be recorded if the work was properly designed and supervised. That the centers are struck too soon may, of course, occur, but only through the most inexcusable carelessness, although it may be used as a convenient excuse for the failure of a bad design.

I hope you will take this up in an editorial, and use your great influence toward abolishing an evil that is disgracing the profession to-day, and seriously retarding the introduction of reinforced concrete construction.

Yours truly, Gunvald Aus.

11 East 24th St., New York City, Nov. 10, 1906.

An Argument in Favor of Cross-Section Books for Taking Topography.

Sir: In your issue of Sept. 27, 1906, Mr. J. H. Eby, E. M., submits an argument in favor of the separate sheet method in taking topography, as opposed to the method of first recording it in ruled cross-section books, as advocated by Mr. F. Lavis, M. Am. Soc. C. E.

His figures, showing the economy of the sheet and transfer method, are misleading in that they show an apparent saving in the draftsman's salary.

The field draftsman is a necessary part of any well-organized locating party, and his cost to the work is the same in either case; if there be any economy in time of one method over the other, it simply means more leisure hours to spend in reading novels or magazines.

My experience in the Rocky Mountains in Colorado, and in the Sierras of Northern California, was always in parties where the cross-section book method of taking topography was followed, and it was noticed that the field draftsman was usually able to keep up his end of the work without much trouble.

The sheet and transfer method no doubt has its uses and is superior under certain conditions. It may work well in a dry climate like Colorado, where it does not rain for months at a time; but it would most assuredly prove inferior to the book method in the mountains of Northern California during the winter months, where the writer saw it rain continually for sixteen days.

As to the degree of accuracy of the two methods, I fail to see wherein either has the advantage. In my opinion the best results are obtained with an organization consisting of a topographer and two chainmen, one of whom carries the rod.

This party is always one day behind the level party, and consequently has a record of the ground elevation at each 100-ft. stake, which the topographer has copied in his book the night before.

Starting from the known elevation at each stake, the contours are traced out on the ground from actual measurements, and by means of a Gurley hand-level and leveling rod, and sketched by eye in the regulation cross-section book used for such purposes.

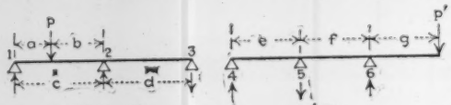
Yours truly,

G. L. Christian, M. Am. Soc. C. E.,
Asst. Engr., Bureau of Sewers, N. Y. City.

Oct. 29, 1906.

Stresses in Continuous Beams or Shafts.

Sir: Referring to the article by Mr. E. Wagner in your issue of Oct. 11, the formulas for reactions and moments in continuous beams can be made much simpler than those given by him. By use of the rules given by me in an article published in Engineering News, April 17, 1902, the formulas given in the accompanying sketch



may be written. These are all that are needed to determine the reactions. With the moment at the middle support known the reactions at the side supports are readily written. For example, the moment at middle support in Fig. 1 is equal to R_3d, or to $Pb - R_1c$, etc. Formulas can be deduced for these relations, if such are desired, which will be much simpler than those given by Mr. Wagner, and would render needless the tables of reactions for special cases.

Yours very truly,

Edward Godfrey.

Monongahela Bank Bldg., Pittsburg, Pa., Oct. 15, 1906.

Inside Guard Rails on the Troy & Greenfield R. R.

Sir: Whatever may be said regarding American railway fatalities and their causes, American engineers certainly appreciate the fact that we have a representative engineering journal, able and willing to take the position indicated in your articles in the Nov. 8 issue regarding the Atlantic City disaster, and present practice in the construction of bridge track and floor systems.

Some of the Boston & Maine R. R. officials may be able to give you interesting facts regarding the equipment in 1884 to 1886 of all the long-span bridges on what was then the Troy and Greenfield R. R. and Hoosac Tunnel R. R., with inside guard rails in connection with rerailing castings that to the writer's knowledge, rerailed wheels, presumably under freight trains, when the train crew failed to report a derailment, the only evidence being marks on the ties leading up to the guard rails. This device was only criticized on the ground common to all such safety devices, namely: The question of the advisability of putting any obstruction between the track rails or attempting to rerail wheels under fast trains.

Yours very truly,

H. B. Potter.

185 S. 11th St., Newark, N. J., Nov. 9, 1906.

Rules of the Canadian Department of Railways and Canals Respecting Bridge Guard-Rails.

Sir: In reference to your editorial in the last number of Engineering News on the wreck at Atlantic City, a good deal might be said about that type of drawbridge, but before making any positive assertions it will be necessary to wait the finding of the Coroner's Jury; I would say, however, that your remarks about the necessity of four lines of guard-rails on bridges are very appropriate and should lead to the overhauling of a good many structures.

The writer would suggest that questions of this character should come under the regulations of some central body, like the Interstate Commerce Commission, and not be left to the individual railways.

In the Dominion of Canada all railroad structures come under the authority of the Department of Railways and Canals and they make certain regulations which are strictly enforced. All bridges are required to have four lines of guard-rails, usually of timber and protected with angle irons on the upper angle next to the rails. If directed or specified, steel rails or heavy angle irons are substituted for the inner lines of guard-rails. These requirements can be found in full in paragraph 114 of the General Specifications for Steel Bridges and Viaducts of the Department of Railways and Canals, Edition of 1905.

Yours respectfully,

Henry Szlapka.

342 Mint Arcade, Philadelphia, Nov. 2, 1906.

The Relative Safety of Swing and Bascule Bridges.

Sir: Referring to your recent editorial on the Atlantic City drawbridge disaster, it may not be out of place to call attention to the many serious accidents of the past year in which this type of bridge has figured. For instance, there have been a number of cases where passing vessels have collided with the center pier, throwing the draw bodily off the pier and into the stream. The most notable occurrence of this kind was the wreck of the great Duluth-Superior drawbridge a few months ago.

Another kind of accident, characteristic of the draw, was narrowly averted here in Chicago this morning, when a rapidly moving street car was only saved from a plunge into the river by the prompt action of the bridge tender, in stopping the Wells St. bridge and swinging it back in time for the car to strike the bridge instead of the gap. Earlier in the year, an automobile plunged into the open draw at Rush St. and caused a number of deaths, and a search of the records will reveal a large number of such fatalities.

The Atlantic City accident has developed still another fault of the drawbridge and the large loss of life attendant upon the discovery of this new source of danger should prompt a careful consideration of the question as to whether or not the old style drawbridge is adapted to modern conditions. It is an incontestable fact that the accident at Atlantic City could not have occurred with a bascule bridge, for the rails on such a bridge move in a vertical plane instead of in a horizontal plane, and if they come to a bearing at all, they cannot be out of alinement. The truss locks establish this bearing absolutely and the indicators give visible evidence of the fact in the operators' house.

As to the other accidents, the open draw is absolutely eliminated by the double leaf bascule, and the writer believes that all single leaf bascules should have the open end protected by a heavy structural steel, motor-driven gate, moving vertically, as is the case with the bridge designed by him and under construction for the County of Camden, at Camden, N. J.

The danger from collisions is likewise small in the trunnion type of bascule bridge; in the first place, because the pier is not so directly in the path of the vessels; in the second place, because the heaviest part of the superstructure is at the pier; and thirdly, because the sub and superstructure are made integral through the medium of the main trunnion.

It is still considered by many that the use of the bascule is not warranted, except at points of congestion, where the absence of center piers and pier protections, the speed with which the bridge is operated, the ease with which it is controlled, and the small amount of room it requires, make it the only satisfactory type of movable bridge. At other points, the issue has been decided entirely on the question of cost, and though the later types have reduced the difference in cost to a very small amount, and, in some instances, have wiped it out altogether, still, generally, this difference is considered sufficient warrant for the adoption of the swing type of structure. This was the case at Atlantic City, where a bascule was rejected because slightly higher in price than the draw.

The modern high grade bascule is a better structure than the draw, and in all respects a safer one, and it is time that this should be recognized and the cheaper and inferior drawbridge be proscribed in all cases where life and limb depend upon the latest and best appliances, irrespective of their cost.

If the regrettable disaster at Atlantic City will bring this about, the sacrifice of life in this, as in other great fatalities, will not have been in vain.

Very truly yours, J. B. Strauss.

903 Fort Dearborn Building, Chicago, Ill., Nov. 3, 1906.

The Atlantic City Disaster.

Sir: Since the publication of your editorial [illegible]ent on the Pennsylvania Railroad's drawbridge at [illegible]tic City in your issue of Nov. 1, the testimony [illegible] before the Coroner seems to establish pretty co[illegible]ely that notwithstanding the official declaration [illegible] the bridge was properly closed and locked, with [illegible]als showing clear and the track in good condition, [illegible] was not the case. There can be little doubt that the [illegible]der did not have the rails properly lined bef[illegible]ting his signals at safety. No doubt he thoug[illegible]ey were in good enough condition, but the startling [illegible] is that any railroad company, and particularly one [illegible]retentious as the Pennsylvania, should be caught [illegible]with a drawbridge of such construction that the o[illegible]tor *could* set his signals at safety while something was wrong with the track.

In operating a drawbridge four movements are [illegible]essary to open the bridge. First, to set the signals at danger; second, to lift the rails and draw the wedges; third, to unlock the bridge; and fourth, to turn it. In closing the bridge these operations follow in sequence in the reverse order, except that the lock may be and generally is made to close automatically. It is not difficult so to arrange the machinery of a bridge as to make it impossible to perform any of these movements except in its regular order, and above all to make it impossible to move any part of the machinery while the signals are set at safety or to set the signals at safety while any of these operations remain undone or not fully completed. Bridges have been built and are in use to-day where the operator cannot move any part of the mechanism until his danger signal is first set. The setting of this signal unlocks the rail lift and wedge machinery and the movement of these automatically locks the signal at danger and unlocks the locking apparatus. When this is moved it, in turn, locks the rail lifts and unlocks the turning apparatus, etc., each operation locking the preceding and unlocking the following movement. In closing the bridge these movements are reversed and the signal apparatus cannot be moved or set at safety until the bridge is locked, the wedges in place and the rails lined exactly right. No drawbridge is safe if it is left to the memory of the bridge tender to decide whether he has or has not done everything that needs to be done before setting his safety signal, and none is safe which leaves it to his judgment to determine whether the rails are exactly right or "good enough" to let a train over. The only safe rule is to assume that any drawbridge may be put in charge of the stupidest or most careless man on earth and then so arrange the machinery that such a man cannot do the wrong thing.

The Pennsylvania Railroad has always plumed itself on being a little ahead of the band wagon in every possible point of view and just a little better than any one else. No matter where you touch them, you find sticking out all over the opinion that nothing is quite as good as theirs. Others may be pretty fair or may even approach excellence in the degree to which they follow Pennsylvania practices, but no one can quite equal them, and as for there being anything better than their way, such an idea is unthinkable! When a man gets into this state of mind it generally takes a pretty hard jolt to knock the conceit out of him, but once in a while he gets it, and the Pennsylvania crowd have been handed out theirs within recent times in such a manner as to show that in spite of their pretensions they are no more than common clay like the rest of us who have never had the advantage of being in the circle of the elect. It was not so very long ago that we had exposed to vulgar gaze the spectacle of a number of their high officials and a good many of the lower ones (all who could get in) being shown up as ordinary sordid grafters just like people who were not so good. And now "America's Greatest Railroad," it appears, has been using back number devices for the protection of its drawbridges, which do not protect.

It would be interesting to those who have to travel on this road to know how many more of their drawbridges depend for the safety of trains on the judgment or integrity of the bridge tenders instead of on such automatic and interlocking devices as are used on other roads which this corporation would rate as fourth class. Or, are the bridge tenders employed by this company so superior to the ordinary run of men employed for such jobs that their judgment and integrity may be depended upon without such additional precautions as other roads consider necessary. Or, is it possible that this corporation actually don't know that there is anything better than they are using? But such an idea is heretical and preposterous.

Chas. F. Stowell.

Albany, N. Y., Nov. 3, 1906.

[We call attention to the fact that the above letter was received after our editorial comment of Nov. 8 was in type but before its publication. The parallelism of the argument concerning the weak link in the operating and signal arrangements will be evident.—Ed.]

The Planetable and Stadia in Railway Surveys.

Sir: Mr. Lavis follows, in an interesting way, well known trails in his new book, "Railroad Location, Surveys and Estimates." But I wish to take friendly issue with him at the slighting and disrespectful manner in which he dismisses the subject of the planetable and stadia method of surveying.

I have found, in my work, the planetab'e stadia an indispensable instrument. It is unexcelled in speed, cost and results for surveys of area and for many surveys of lines. For developing topography over a broad stretch of territory every other method is as absurd as traveling by stage coach when the railway is available. But all this is writ with a very large PROVIDED, namely, that the instrument is of suitable pattern and the operator skilled in its handling. Disregard of these provisions has led to poor opinions of this most useful instrument.

The chief engineer of a neighboring railway lately ordered a planetable stadia outfit after hearing the method warmly commended, but when it was delivered it might well have moved to derision a back-flagman. The telescope was framed upon four sharp supports and adjusted with many screws and tangent threads; among others an adjustment to bring the line of sight parallel with the fiducial edge. The planetable movement had sundry levelling screws, a detached compass and set of spirit levels. The whole apparatus was so clumsy to transport and handle, so slow and cumbersome to operate that I could well imagine the disgusted operator giving the ultimatum at the end of his first day's work: "Give me a transit and level or get another man." I advised the engineer to scrap the purchase and obtain a "Johnson" movement, a 24-in. × 24-in. board, having a 4-in. compass inserted in the edge and a U. S. Geological Survey pattern alidade, as made by Saegmuller; also to have a circular bubble attached to the blade. This outfit is quick and handy; but even with it no satisfactory results should be expected until the operator has had four weeks' continuous practice. He must learn to play on it as he would on a typewriter machine; and until mastered the results will be slow and unsatisfactory. Once mastered, however, it will repay the expense of time spent in its mastery.

My trained men frequently make 100 instrumental stations, or set-ups, in a day's run, averaging about five miles, linear, over rolling farming country in the South, some 300 ft. of topography being covered on each side of the line. The scale found most serviceable is 400 ft., with contours at 5-ft. intervals. Line and profile projected from this topography will not differ materially from the same line run out with transit and level, that is, it will afford all the data required for a preliminary line for determining if the route is available and its approximate cost, and at about half the cost of such data obtained by conventional methods. Indeed, any topographer skilled with the planetable may safely contract for line or area work at half the probable cost of such work by transit and level.

In covering areas, or exploring lines in advance of railway location, the planetable-stadia method is especially to be commended for speed as well as economy. One instrumental party will commonly throw out a "feeler" at the rate of five miles a day, and two instrumental parties will develop topography over quite a broad belt as fast as location can advance. Any bright boy who is quick at figures will serve as aid to the instrument man, computing elevation from rod reading, carrying the instrument between stations and holding the shade over the table. I have frequently worked with but two laborers, a boy and a rodman. Sometimes, however, it is desirable to have two rodmen and axemen, although in a country half open, as are the Southern farming areas, an axeman is rarely required. The rodman, nevertheless, may well carry a hatchet in his belt for occasional use. In the dense undergrowth of river bottoms at least six laborers, all told, in addition to the skilled instrument man, may be required to make two to three miles daily.

Whenever possible the day's run should be tied to a check point to guard against personal errors. A line may be brought back on itself, or two parties running parallel lines may close at the end of a day's run. If no bad blunder has been made, the line should close after a five mile interval with an error not exceeding 3 ft. in level and 200 ft. in position. I frequently have lines close with only a few tenths of a foot error in level and no appreciable error in position, (scale 400 ft.)

It requires an expert man only five minutes to set up, level, orient, take four rod readings, plot and draw contours. The average distance from station to station when 100 stations are made in a day's run, will be 250 ft. From each station there will average a backsight, two side-sights and a fore-sight, or 400 rod readings in the run of 100 stations. The number of stations which may be made in a day's run depend chiefly upon the length of shots. Level and stadia may be safely read at 600 ft. in good conditions of the air, on cloudy days or late in the afternoon. In country so thick and rough that every sight is but feeling in the dark it is still possible to cover two miles in a day's run, with not more than four axemen.

I repeat that whatever the nature of the country, it is possible to take the topography with the planetable-stadia method at about half the cost of the transit and level method. I most heartily commend the planetable to the favorable consideration of engineers, particularly as a preliminary to railroad location.

John W. Hays.

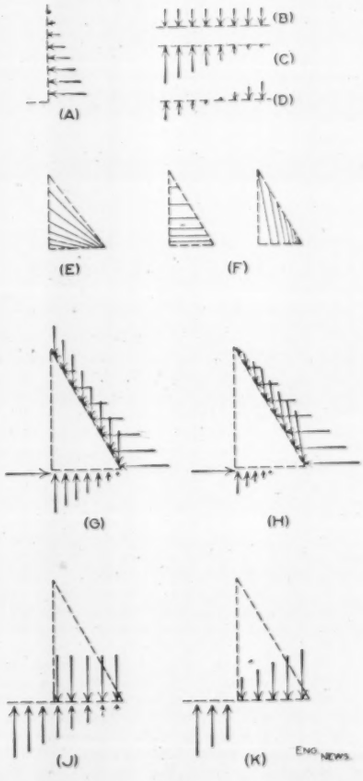
Petersburg, Va., Oct. 15, 1906.

The Design of Reinforced-Concrete Retaining Walls.

Sir: The article in your issue of Oct. 18, by Edward Godfrey, on the "Design of Reinforced-Concrete Retaining Walls," was of especial interest to the writer, because it so closely conformed to the methods of design lately developed by him in checking the computations for a very high and long wall about which he was consulted.

Differences of opinion may exist as to proper methods of determining the lateral pressures exerted by earths of different qualities, and as to the proper design of reinforced concrete beams, etc., but certain fundamental principles exist in accordance with which every proper design should be prepared, and it seems to the writer that Mr. Godfrey has come nearest to stating them of any one with whom the writer is acquainted.

The writer's experiments on lateral earth pressures, reported to the American Society of Civil Engineers, led him to the opinion that the angle of surface repose for most earths is entirely different from the angle of internal friction of the same earths. Manifestly it is the latter which should be used in most design work instead of the former. The writer agrees with Mr. Godfrey, however, that the actual active pressures may with sufficient accuracy be considered as fluid in effect, and a certain percentage of the weight of the earth backing in amount.



The experiments above referred to seemed further to show that for walls more than about 5 ft. high the pressures varied practically as the depth, so that their resultant might, with sufficient accuracy, be considered as acting at the lower third point of the height of the wall. For walls of less height, however, this point of application rose often to a point four-tenths of the height above the base. In most walls, then, the lateral pressures would be represented by a triangular diagram of horizontal arrows, having a horizontal base (sketch A).

The writer is in direct accord with Mr. Godfrey where he uses a bottom slab weighted by the superimposed earth, and agrees that the resultant downward pressure of the earth on this slab may, for all practical purposes, be considered as uniform (sketch B) unless the design employs a greatly extended toe, as is often necessary with high walls on soft soils.

He also agrees with Mr. Godfrey that many designs are faulty in the arrangement of the reinforcement in the bottom slab, probably from wrong assumptions as to the distribution of the resisting earth pressures.

While some experiments lately carried out by the writer (which are now being repeated) shed some new light on the distribution of resisting earth pressures under walls and foundations, still for the moment a uniformly varying distribution may be assumed, and, provided the resultant of the two series of forces above described intersects the base of the wall at the front edge of its middle third, the variation is from zero at the back to twice the average at the front (sketch C).

The diagram of resultant forces on the slab will then evidently be two triangles, as described by Mr. Godfrey (sketch D).

The horizontal forces are, of course, resisted by the sliding friction between the base of the wall and the earth beneath, and by the pressure of the toe of the wall against the earth in front of it. This front pressure may be considered as distributed uniformly over the base like the friction, for sake of convenience.

These assumptions take care of all the external forces.

If the slabs in front and base are to be tied directly together by diagonal rods in the counterforts, these rods must be given varying slopes (approximately as at E in the sketch herewith) to correspond with the varying pressures in front, while their bottom ends must be similarly spaced to correspond with the resultant downward earth pressure. Then, too, these rods would have quite different stresses due to their varying slopes, so that the proper distribution of diagonal rods of uniform diameter is a very complicated affair to determine. Evidently, if some satisfactory arrangement of horizontal and vertical rods can be devised to produce the same effect several advantages will be gained. Even the arrangement proposed by Mr. Godfrey (the correctness of the design of which the writer strongly questions) is rather costly in execution, because simple horizontal and straight, approximately vertical rods are much more easily placed by inexperienced labor.

Such horizontal and vertical rods in the counterforts, if spaced to correspond with the assumed forces, will have a uniformly varying spacing one way to correspond with that which theoretically should exist on the face, and a similar one in an approximately vertical position the other way, the upper ends of the rods running to all points along the back of the counterfort, while their lower ends cover that part of the base over which the resultant earth pressure is assumed as acting downward (see sketch F). These rods simply carry to points within and along the backs of the counterforts the active earth stresses, so that the resultant diagram may be drawn as shown at (G) when primary stresses alone are considered, and as at (H) when the resultant earth pressures and rod actions are considered.

Now the concrete in the counterforts being highly resistant to compressive stresses, easily resists the combined action of these loads and the whole counterfort is much better tied together than in Mr. Godfrey's design. The latter seems a little inconsistent in not better reinforcing the counterforts after employing more steel than theory requires at several other points. A similar inconsistency crops out in the omission of any steel in the steps which are supposed to carry over into the face of the wall the upward pressure near the front under the bottom slab. Unless the concrete is considered as taking some tensile stress, reinforcement should be employed in some manner in these steps, either to make them act as beams of variable depth carrying the upward pressure to the counterforts, or as brackets attached to the inside of the front face. Under the latter assumption horizontal rods perpendicular to the face should be introduced in the bottom slab. These rods should also be carried through the plane of the face and into the toe projection, which must often be greatly extended, and the design of which Mr. Godfrey does not consider even though he shows such a toe in his diagrams.

If the remainder of the bottom slab outside the stepped portion, besides acting as a vertical beam to take earth pressures, is considered as a horizontal beam designed to resist the stresses which the lateral rods might be introduced to resist; then proper additional ties should be introduced in the counterforts. Mr. Godfrey's angle iron would not seem of sufficient size to cover the usual needs.

It is believed, further, that the practical construction of the forms for Mr. Godfrey's stepped wall will be more costly than for a wall without the steps and with steel introduced instead.

Whenever the weight of a cubic foot of the earth backing multiplied by the height of wall exceeds half the safe bearing power of the soil, an extended toe must be employed. In that case the diagram of vertical stresses may be assumed as in sketch (J) and the resultant downward effect on the bottom slab may or may not reach zero behind the face. A diagram somewhat like that of sketch (K) will result.

In this case the rods in the counterforts which are designed to carry these vertical resultant stresses will themselves be nearly or quite vertical. The exactly vertical condition would occur when the resultant earth pressure becomes zero under the face of the wall, which condition would take place when the toe is extended a distance outside this point approximately three-tenths of the

total width of base. This amount may seem rather large, but is not unknown.

With such an extended toe a series of steps in the outside of the wall would be very proper because no counterforts are available, and since the face of the wall is in close proximity. Properly arranged steel would be very necessary unless tension is to be allowed on concrete.

What Mr. Godfrey says with regard to end anchorage of rods, the writer believes to be eminently correct, except that the writer's experiments have shown that proper hooks are entirely satisfactory. The writer further agrees with Mr. Godfrey in always advocating steel in beams and slabs to take up reverse moments at points of support, except that he feels that the design of the slabs as simple beams with extra reverse reinforcement added, is erring too much on the side of safety even with regard to the exceedingly uncertain knowledge we now possess as to earth pressures and reinforced concrete continuous beams.

The writer has been greatly interested in Mr. Godfrey's design, but considers that the one briefly described above is more logical and more economical of execution, especially as to labor.

Yours truly,

E. P. Goodrich.

1170 Broadway, New York, N. Y., Oct. 18, 1906.

Questions Regarding Changes in the Contract for the Gowanus Canal Flushing Tunnel, Brooklyn, N. Y.

Sir: With, I am sure, many others, I would like the views of Engineering News on the following matters:

Nearly a year ago there was let by New York City (Borough of Brooklyn) a contract amounting to over $700,000 for a water tunnel for flushing the Gowanus Canal. The tunnel was to be 6,270 ft. long and 12 ft. in diameter. It was to be built in either one of two ways: (1) an ordinary circular brick tube 16 ins. thick, shown by plans and governed by firm, clear specifications; (2) "Concrete . . . enclosed with a cast-iron segmental tube 1⅛ ins. thick." The segments of cast iron [see illustration—Ed.] showed the regular ribs and flanges, bolting, etc. Inside of this iron tube the plans showed 8⅞ ins. of concrete lining, Portland cement 1:2:4; 2 ins. of this to be facing. Here, too, the specifications were explicit, so that the tunnel was to be either of brick or of concrete and cast iron combined; the contractor had his choice. Part of the above 6,270 ft. might be built in open cut where the ground is low. [All might be so built, at the option of the contractor.—Ed.] Open cut work, however, is shown, and provided, to be built either of brick or reinforced concrete, as is the common practice, with haunch foundations, and spandrels of the respective materials. Here, too, the contractor had his choice of two materials, and a further choice of building all either open cut or tunnel. He decided to tunnel the whole of it. Therefore I will attempt to discuss only tunneling.

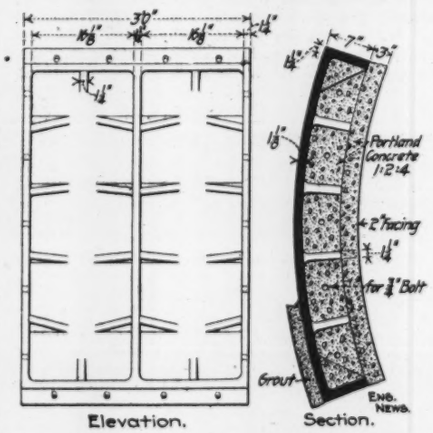
When the contractor got the work he started, not the job, but an intrigue, or let us say, discussion. He proposed to the city officials a change in the method of constructing the tube. First, he wanted to make segmental brick blocks, or voussoirs. The brick and mortar were to be put into iron molds, the blocks being the thickness of the brick tubing shown on the plan (16 ins.), 2 ft. long on the base or longitudinal joint and 3 ft. high, measured on the intrados. After those blocks hardened they were to be taken into the tunnel and set up. Samples were made and are still to be seen. It has not come to light that the contractor was to allow the city anything for this change. After over half a year's endeavors in that direction the whole scheme was abandoned, nobody on the outside knows why. Therefore the brick tubing in any form is dismissed, also, from further consideration here.

But now after nearly a year, or one-half the time in which the contractor was to finish the work (not a foot of tunnel built yet), an amended contract and specifications for a far more radical change comes forth, apparently approved by all city officials and only awaiting the clinching authority of the Board of Estimate as to legal form.

The idea this time is, and it seems to be accepted all around, to leave out the cast-iron tubing altogether and to increase the concrete lining from 8⅞ to 16 ins. in thickness. The new construction is not to be of the monolithic style originally provided for, but is to be made outside in blocks similar in size and shape to the brick ones mentioned above; no reinforcement of any kind is to be used. Some dozen samples, or one complete ring, of these blocks are now on exhibition out in the lot.

For this, no doubt last, change the contractor, it seems, is to allow the city $6 per ft., or $37,620 of the contract money; added to this the cost of the increased thickness of concrete and the additional excavation displaced thereby, makes about $74,000; deduct this sum from the cost of the cast-iron tubing and there will be found between $225,000 and $240,000 of a clear clean-up for somebody. It is at this point, when the deal is about to be consummated, that outsiders break in and object to the whole thing.

Among others, the writer objects, partly for the following reasons: It is unfair to the competing contractors, unfair to skilled labor, it puts the city in the role of a private bargainer where a large amount of public money is involved, if not wasted. It is a premium to intriguing in municipal contracts, endangers the permanence of an important public utility—as I claim the engineering features of the new construction are questionable, though city engineers fervently assure me to the contrary. I claim the samples of concrete voussoirs now on exhibition lack all qualifications: First, the concrete is put into the mold with the latter lying on its side, as it were; it cannot be put in in any other way because of the curved form. When the block is in place in the tunnel the bed or seam of each layer of concrete composing it, is, not at right angles to, but parallel with the line of resistance or center of pressure, something like cementing three slabs together and standing them up to receive the load, or a block of quarried stone laid with the natural strata or seam vertical instead of horizontal. Then the base or longitudinal joint of the manufactured block is seen to be one-third less in length and area than the vertical or upright joint. Again, the bond is to be only 1 ft. to 3 ft. rise, or circle, like a structure built of paving stones set on end. It is highly questionable if the blocks could be made with anything like true lines, and put in place without chipping or straining, and it would be next to an absolute impossibility to



Concrete and Cast-Iron Lining Proposed as Alternative to 16-In. Ring of Brick for Gowanus Flushing Canal, Brooklyn, N. Y.

get tight joints in the arched half of the tunnel, if in any part of it. The sample brick voussoirs were also made with all brick put, or laid, on end, in the mold.

With the block construction each lineal foot of tunnel will have a joint surface area equal to 43 sq. ft.; 13 lin. ft. longitudinally and 20 ft. circumferentially, running clear through the tube walls; those joints cannot be made tight. The tunnel runs through fine beach sand under a thickly populated section of the city, most of it from 50 to 70 ft. below the streets. Leaks would soon choke it. It is always submerged except at extreme low tides, when perhaps it is not entirely full. Except for a few hundred feet at each end, the action and penetrating force of the water on the roof joints at least, and through any voids in the concrete blocks, will increase in alternate directions with the rise and fall of each tide, the surrounding ground being sandy. To these faults and to others not mentioned here, the city engineers now shrug their shoulders. On the moral side of the question they are mute.

The plans under which the contract was let are signed and approved by four leading officials, headed by a borough president. They were exhaustively discussed and corrected by them before advertising. Two of the officials are able engineers, experienced in their branch of their profession; as far as known, neither of those engineers now advocate the change.

Will Engineering News give its views on the matters submitted above, ethical, engineering, and legal? Are there tunnels of such block construction? Is steel reinforcement of light concrete structures a mistake after all?

Respectfully,

Michael O'Sullivan, General Contractor.

349 55th St., Brooklyn, N. Y., Oct. 29, 1906.

[Proof of the foregoing letter was sent to the leading borough officials of Brooklyn. We publish immediately below the only letter received in response thereto, and further on we print still another communication. Mr. Creuzbaur, it should be explained, is Consulting Engineer to Mr. Bird S. Coler, President of the Borough of Brooklyn. His letter follows.—Ed.]

Sir: Your correspondent, Mr. Michael O'Sullivan, his communication of Oct. 29 on the Gowanus C... Flushing Tunnel, has injected much that is misleadi... The engineering questions involved may, however, ... of some general interest, and I submit the salient fea... tures of the case as requested.

The contract bid amounts to about $715,000, of wh... the main item is 6,270 lin. ft. of 12-ft. circular cond... at $100 per ft. The other bids were $130 and $135 per ... At the contractors' option, this conduit may be built ... tunnel or open cut of either four rings of brick (16 in... or of a composite section of 1¼-in. cast-iron segmen... ribbed 5⅞ ins. deep, filled and lined with concrete to th... 12-ft. bore, giving a 10-in. wall thickness. The c... under the latter plan is greatly in excess of plain bri... construction, and this so-called alternate plan is ... course outside of the present proposition.

The material encountered in borings indicates coa... sand generally, that now exposed being sharp a... gritty. The tunnel is entirely submerged at low wate... the invert being on a level grade 18.5 ft. below mea... high water.

On the writer's first connection with this work th... contractors had proposed to build an all-brick tunnel of 16-in. blocks, there being 14 in the circle, measurin... 24 ins. longitudinally and about 31 ins. on the inside chord. These blocks were to be cast in metal molds, and were to be well seasoned and subjected to surface inspection. The claim had been made that the material encountered at depths ranging from 15 to 50 ft. would impose such a load on green brickwork as to render the usual tunnel construction methods unsafe without a prohibitive length of iron centering to carry the ordinary brick ring until the mortar reached its ultimate set, and furthermore that as the materials were identical there was no departure from the contract requirements.

The contractors' engineer stated that while the engineer in charge of the work had not given consent in writing to the "brick block" construction, he had definitely approved it on several occasions and was fully aware of a formal proposal to sub-contract the work on this plan. The engineer in charge at that time properly refused to have the city assume any risk of the success of the brick block construction until a section had been built. No reduction in time of completion was contemplated or any allowance to the city for the saving effected by doing away with full brick laying gangs working under air pressure.

At this point the writer took up the matter as consulting engineer for the borough, and advocated 1 : 2 : 4 concrete block construction of Portland cement and clean North River trap, and called on the contractors, the engineer in charge of the work, the engineer of design, and others, for all possible comparative data of cost of usual brick tunnel work, brick block work and concrete block work, and these figures were submitted to city authorities, with the result that the corporation counsel was asked to draw up a supplemental agreement, which was to be referred to the Board of Estimate and Apportionment, where further engineering advice would guide the vote of the board.

The writer in advocating concrete voussoirs had required as a condition of the change that the contractors complete the work in 500 working days, instead of 600, as originally provided. This was considered of great importance, as the foul condition of the canal is causing great complaint, the assembled property interests claiming that some thirty public sewers carry dry weather flow into the canal, and these interests are now endeavoring to secure state legislation similar to that prohibiting discharge of sewage into Newtown Creek.

The concrete blocks were to be made in heavy reinforced steel boxes, true to a 1/16-in. variation from standard, tested at 30 days to 2,500 lbs. per sq. in. in 6-in. cubes and the finished voussoir was to be seasoned 60 days before using. Joints were limited to ⅜-in., and owing to the strength and homogeneity required and accuracy of the block dimensions guaranteed it was believed that deformation of circle would be slight. The price was to be $94 per lin ft. of tunnel..

The main advantage of the proposed change to concrete blocks was in eliminating the uncertain quality of workmanship in a tunnel laid in brick under pressure, the limited depth of working space and the length of shield movement (assumed at 3 ft.) making effective inspection of more than the inner ring of brick particularly difficult.

Mr. O'Sullivan asks Engineering News to give views on this matter "ethical, engineering and legal." As to the first, it is granted that after competitive bidding on a certain basis it is generally bad practice to modify plans and prices and that this must lead to criticism. I have seen much city money wasted by such conservatism, however, and in this case the belief that a much safer tunnel could be built and the certainty that valuable time would be saved to the city, with a saving of about $38,000 in the cost of the work, caused me to advocate a change in the contract. At that time the modifications then approved by the engineer in charge were definite, and provided for brick voussoir construction with no allowance to the city in time or money.

As to the legal view of the case, according to an

opinion recently received, the board of aldermen should approve a modification as proposed. On the engineering question criticism from the viewpoint of practical constructors would be welcomed as showing what probable difference there would be between the specification requirements and the actual finished four-ring brick tunnel, comparing the latter in strength and durability with a 14-segment concrete tunnel composed of homogeneous material for the full 16 ins. depth, and, unlike the composite iron-concrete sections of our river tubes, liable, I believe, to material deflection under loading. It is now improbable that any change will be made from the ordinary brick masonry laid as the contract provides, but concrete voussoir construction may be allowed in some future work, for which plans are under preparation, for sewers ranging up to 18 ft. in diameter, to be built in tunnel.

Very truly yours,
R. Walter Creuzbaur, M. Am. Soc. C. E.

Brooklyn, N. Y., Nov. 5, 1906.

[The engineer of sewers for Brooklyn at the time the contract in question was drawn, and also when the various changes were proposed, was Mr. Henry R. Asserson, M. Am. Soc. C. E., who resigned that position only a few days ago. Proof of Mr. O'Sullivan's and of Mr. Creuzbaur's letter having been sent to Mr. Asserson he has submitted the reply given below.—Ed.]

Sir: With regard to the Gowanus Canal flushing tunnel and concerning the matters contained in letters relating thereto by Mr. Michael O'Sullivan, of October 29, and by Mr. R. Walter Creuzbaur, of Nov. 5, I desire to state that when the contract and specifications were drawn by me for this work it was stipulated that about one-half of same was to be built in open cut, the other half in tunnel construction.

The contractors were required to bid upon two estimates, one setting forth brick construction, the other concrete construction. The lowest bid of either class of work was to determine which was to be used. The open cut concrete section was to be reinforced while the concrete tunnel work was to be incased with cast-iron ribbed segments, 1⅛ ins. thick. Bidding for work in this manner precluded unbalanced bidding, which of late has been of much detriment to the city's interest.

Before the contract was bid for, the then Commissioner of Public Works, Mr. J. C. Brackinridge, ordered the plans and specifications changed, making it optional upon the contractor's part to build the entire construction in open cut or by tunnel, or any length thereof, as the successful contractor should so choose.

I have never been, nor am I now, in favor of bidding upon any work along these lines.

With regard to the changes contemplated by the contractor and his engineer in the method of construction, that is by building the work of brick voussoir or concrete voussoir construction without iron encasement or reinforcement, I desire to state I have never favored such change, nor consented to such change, having repeatedly stated that such construction would be experimental, and I believed impossible to build, securing good work. I have steadfastly refused to sanction the changes which Mr. Creuzbaur states that he recommended. It is recorded that I ordered the contractor to proceed with his work in accordance with the terms of his contract and have never changed said order.

How Mr. Creuzbaur arrives at his figures used in his recommendation I do not know. None of them were ever furnished by me. Yours very truly,

Henry R. Asserson, M. Am. Soc. C. E.

59 Pearl St., New York City, Nov. 12, 1906.

[We are pleased to learn, from Mr. Asserson's letter, that he was not responsible for the specifications forming a part of the contract (a copy of which was submitted to us with Mr. O'Sullivan's letter). Under those specifications, if we understand them, the successful bidder had his choice, *after the contract was awarded him*, of four different designs and methods of construction. This we think the most serious feature of the whole case, and we do not wonder that such an opportunity for chicanery has given rise to controversy.

As the tunnel will probably be built, at last, in accordance with one of the four plans allowed by the contract, and as all the borough officials have changed since the contract was let, we do not think it worth while to discuss further the moral or legal aspects of the change formerly proposed. Regarding the purely technical features involved, and more particularly the relative merits of ordinary brickwork and concrete blocks, our columns are open to the opinions of our readers.

We may point out, what most of our readers may have seen for themselves, that since the contractor had a free hand to choose any one of four methods of construction, no one can blame him for choosing whichever promised to be cheapest (none of the four seemed to suit him, though), and therefore in considering any proposed substitute its cost should be compared with the cheapest of the four plans submitted by the contract, and not with the most expensive.—Ed.]

Notes and Queries.

"X," Ottawa, Canada, is informed that no communications can receive attention unless they are accompanied by the correct name and address of the writer, which need not, however, be published.

A HIGH-SPEED ELEVATED MONO-RAIL ROAD for Brooklyn was advocated by representatives of the Behr mono-rail system at a meeting on Nov. 8 of the Committee on Plans of the Rapid Transit Commission. The proposed road would extend from the Atlantic Avenue ferry in Brooklyn to Coney Island, and if built would be the first mono-rail railroad constructed and operated in the United States. Mr. F. B. Behr, the inventor of the system, stated to the commission that the road could be built within twelve months, and that the matter of financing the building of the road would be undertaken by a corporation which he could form as soon as the franchise was granted. He said the cars would be capable of holding 170 seated and 80 standing passengers, and an average speed of 65 mi. per hr. including stops, would be maintained, although it was possible and safe to run the cars at a speed of 120 mi. per hr. The committee will probably report regarding the adoption of the system, to the full Board at the next meeting.

ATTRITION TESTS AND PETROLOGICAL DESCRIPTIONS OF BRITISH ROAD-MAKING STONES.

Some interesting and valuable information on the characteristics and availability of different broken stones used or of possible use for road making in Great Britain are included in a book recently published in London.* The tests were initiated by Mr. Lovegrove in connection with his duties as Borough Engineer of Hornsey. Mr. Lovegrove, in his introduction to the book in question, states that the ordinary method of judging the value of road-making stone from the results obtained in its use are liable to be very misleading when an attempt is made to apply these results elsewhere, inasmuch as the character of the subsoil and foundations, traffic, wind and weather exposure, etc., have very great influence on the durability of road metal. The most scientific laboratory test heretofore attempted, he believes, is the attrition test. For, while that test does not absolutely indicate the resistance of the road to wear, it is nevertheless a factor of great importance. A combination of the attrition test and the petrological examination of the rock or study of its composition and texture, illustrated by photomicrographs, promises to be far more useful than either one alone.

In his attrition tests Mr. Lovegrove takes account of the dust as representing the "cash outlay in waste, due to the effect of the wear and tear of the traffic and the grinding action which takes place in the layer of macadam itself." The chips, he holds, "may be considered in a measure as an indication of the brittleness" of the stone, but it must be remembered that "these chips, working into the road, assist in reinstating the fabric of the road crust," so that if only the rock in question is "fairly tough" a moderately large percentage of chips "may not be disadvantageous." If two given samples lose approximately the same percentage of dust in a dry test, Mr. Lovegrove holds that the difference between the dust losses in the wet and dry tests is a probable indication "of the superiority in wet or frosty weather of one stone as compared with another." He records the specific gravity as a matter of general interest "and as a possible guide to freight charges."

In his tests Mr. Lovegrove employed three rotary cast-iron cylinders 11 ins. in internal diameter, provided with three 1 × 1-in. angle iron ribs bolted longitudinally to the inside of the cylinder at equal distances apart. The cylinders were driven by a gas engine. Stone for testing was broken to 2-in. gage, and each charge numbered about 16 pieces weighing 4 lbs. The revolutions per charge, as recorded by a counter, was limited to 8,000, and the speed to 20 r. p. m. The largest piece of stone termed a chip does not exceed the weight of ¼-oz. In the wet tests about ½-gal. of water is placed in the cylinder with the stone. After the test is completed the chips and dust are thoroughly dried and their weight compared with that of the stone before wetting.

Samples of all stones listed in the book are deposited at the Museum of Practical Geology (London), accompanied by proper test records and description.

In the general conclusions to that portion of the book contributed by Messrs. Flett and Howe, it is stated that "the attrition tests, enforced by a knowledge of the mineral composition and structure of the stone, indicate most clearly what are the best varieties of stone in each group." Whatever tends to porosity in the stones "is disadvantageous, whether it be the absence of cementing substance between the grains or a tendency in one of the mineral constituents to cleave." In general, the wet tests show higher dust values than the dry, pointing "to the action of the incompressible water exerting a disruptive pressure within the crevices with every blow and shock." It is suggested that this point has a bearing upon and may well be considered in connection with the waterproofing of porous stone. The final part of this section of the report may be quoted as follows:

There is much confusion among practical men unacquainted with petrology, arising from an improper conception of the meaning of the terms "fresh," "altered," "decomposed," as they are applied to rocks or the minerals composing them.

If we use the terms "fresh" and "decomposed" = rotten, we in general convey the ideas of goodness and badness, respectively; this is not the case when reference is made to rocks. When we speak of a mineral being in a fresh condition we mean that it possesses its inherent properties in an unimpaired state; if the original or primary minerals are not altered by subsequent processes they are said to be "fresh." A fresh rock is one in which the minerals that compose it are fresh. When a mineral within a rock alters or is decomposed as the result of certain forces acting upon it, it breaks up usually into one or more *new minerals*, each one in its own way being as "fresh" as the original mineral.

It is possible for the alteration of a rock to make it actually stronger than before. Some of the new minerals produced by alteration (molecular rearrangement) may be an improvement upon the original; others may be the reverse. When a rock is acted upon by surface weathering agents it frequently happens that certain selected mineral substances are removed, and it is thereby weakened, or softer minerals are introduced.

For this reason it has been suggested that the term "decomposition" should be confined to surface weathering, while "alteration" is maintained for more deep-seated molecular rearrangements within the rock; but the suggestion is not regularly acted upon.

The microscopic examination of the rock shows what the action of the alteration is, and whether it is likely to be beneficial or not in its effects; thus the alteration of augite to chlorite produces a result that is usually inferior to the original in wearing properties, while the alteration to uralite appears to be superior.

The very best rocks in these tests are altered rocks, and as a general rule a certain amount of alteration of the felspars seems to be an advantage. The reason for this is that the alteration produces a *number* of mineral units where formerly only *one* existed; in other words, the texture is made finer and often the interlocking of the grains is made more complete. A large fresh crystal of felspar, by its rigidity and perfection of cleavage, is less able to resist impact than the same volume of substance in the condition of an intimate mixture of granules of mica, sericite, kaolin, or epidote, especially if they are united by a quartzose cement, as is frequently the case.

In short, alteration by reducing the size of the grains and felting them more closely tends to enhance the *toughness* of the stone. It is only when large quantities

*"Attrition Tests of Road-Making Stones."—By E. J. Lovegrove, M. Inst. C. E., Borough Engineer and Surveyor of Hornsey. With Petrological Descriptions by John S. Flett, M. A., D. Sc., F. R. S. E., Petrographer H. M. Geological Survey, and J. Allen Howe, B. Sc., Curator and Librarian of the Museum of Practical Geology. London, England: The St. Bride's Press, Ltd.

of soft minerals are introduced, or some ingredient is removed, usually by surface agencies, that alteration is liable to be inimical to the wearing properties.

Fineness of grain makes for toughness in all classes of stone. A stone made of heterogeneous particles or minerals will wear better in a fine-grained condition than when coarse, but if the grains are somewhat large, provided they are fairly uniform in size and held together by a fine matrix, the stone may wear as well as a finer-grained one.

Great care has been taken in the foregoing notes to avoid complicating the present issue by references to any of the stones in road practice. We have set ourselves to examine what light could be thrown upon the attrition tests by the microscopic examination of the stones. Notwithstanding certain evident imperfections, we are satisfied as to the practical utility of combining these two testing instruments, and we believe that, after working carefully through the series of stones with the microscope, it is possible to forecast the behavior of a new stone, from the thin section, with very fair accuracy.

RAILS AND RAIL-LIFTS ON THE THOROUGHFARE DRAW NEAR ATLANTIC CITY, N. J., NEWFIELD BRANCH OF WEST JERSEY & SEASHORE R. R.

On Sunday, Oct. 28, 1906, an eastbound train of three cars running on the West Jersey & Seashore R. R. Co.'s new electric line between Camden, opposite Philadelphia, and Atlantic City, N. J., was derailed at a deck drawbridge over a tidal inlet, the Beach Thoroughfare, just outside of Atlantic City, and all three cars went over the side of the bridge into the water, killing most of the passengers on board. The cars were new and in good condition, the track was solid and of heavy construction, and the interlocked semaphore which protects the bridge was cleared by the towerman before the train approached the bridge. It was evident at once that an accident of remarkable character had occurred, remarkable for more than merely the large number of victims.

The photograph reproduced as Fig. 1 of this article shows the point where the derailment took place. The view is toward the east, from a point on the eastbound track just west of the drawbridge and looking toward the bridge. The rail which is bent out of place is the right-hand rail of the eastbound track, and is the end rail-length (at the west end) of the bridge. Its end extends about 2 ft. over onto the adjoining fixed trestle, where it makes a scarf joint with the fixed rail. When the bridge is to be opened, the end of the bridge rail must be lifted out of engagement with the fixed rail, high enough to clear both rail and guard-timber. When the rail is down in place (bridge closed), several guides hold it in place. As the view shows, the rail in question was knocked out of its guides, and bent nearly two feet inward. Moreover, the bevel point (outside) of the scarfed rail-end is battered and abraded at the head of the rail. The clear indication is that the wrecked train struck this sharp end of the rail, battered it by successive impact, and ultimately forcibly bent it inward to the position shown.

The evident fact that the rail-end was out of its proper place in the joint-socket directs attention to the mechanism involved in operating the rail-ends and the ends of the bridge when the bridge is opened or closed. On this account we present here the drawings, Figs. 2 to 5, reproduced from official blueprints of the structure. The machinery shown is in accordance with rather common practice in draw-spans. For example, the draw-span at the crossing of the Atlantic City R. R. (Philadelphia & Reading Ry. system) over the Thoroughfare less than 200 ft. north of the bridge in question, has end machinery practically identical with that shown (the rail-guides, however, are of different design).

The following remarks are given in further explanation of the drawings. It is the purpose not to comment on the bridge machinery or accident, but merely to make clear the natur

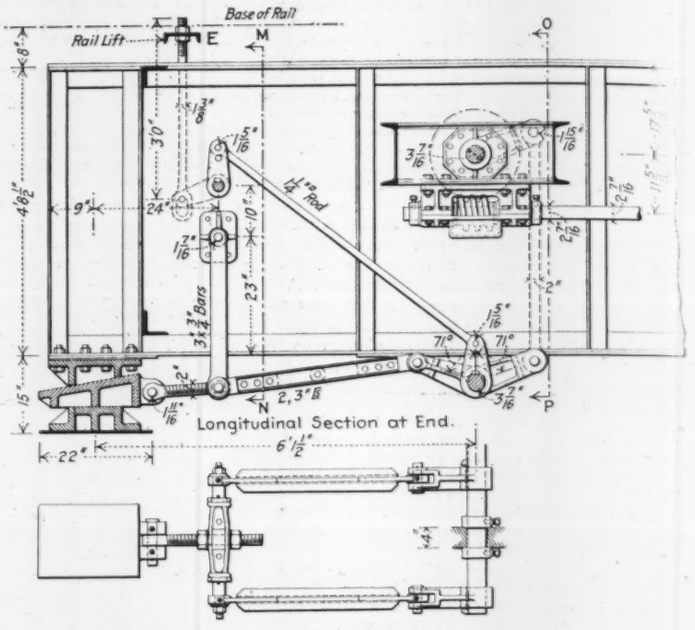


FIG. 4. SECTIONS AT END OF DRAW-SPAN,

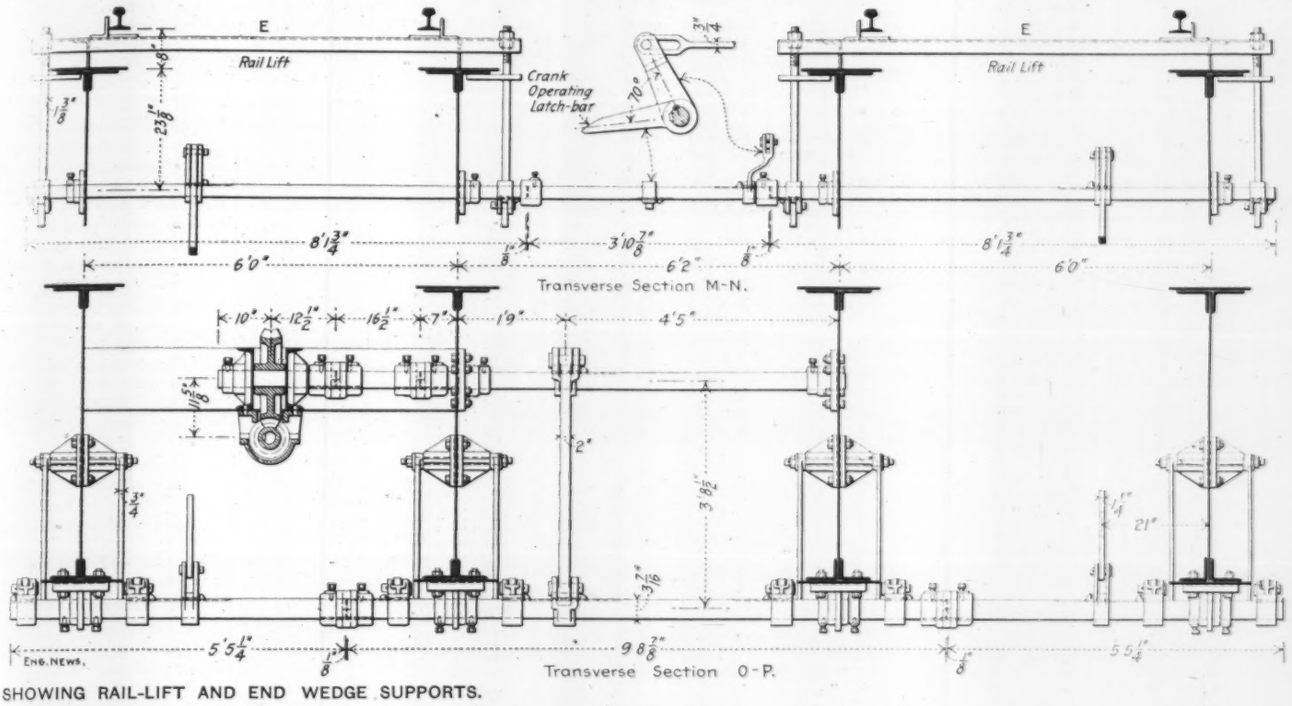
the operating devices, in order that the engineering reader may have a clearer idea of the structure involved in this remarkable and disastrous derailment.

The tidal creek known as the Thoroughfare is about 500 ft. wide where the railway crosses, and the draw-span, 110 ft. 4 ins. in length over all,

FIG. 1. VIEW OF RAIL JOINT AT WEST END OF EAST-BOUND TRACK ON DRAWBRIDGE OVER BEACH THOROUGHFARE, ATLANTIC CITY, N. J.

[An electric train of three cars was derailed at this point on Sunday, Oct. 28, 1906, at 2.30 p. m., and, after running 250 to 300 ft. on the ties, went over the right-hand side of the trestle beyond the draw and fell into the water. About 60 persons were killed.]

is near the middle of the crossing, so that about 200 ft. of trestle in water adjoins either end of the draw. At the east end the line continues on trestle a few hundred feet farther to a series of steel girder-spans crossing over the tracks of the Atlantic City R. R. The rise necessary for



SHOWING RAIL-LIFT AND END WEDGE SUPPORTS.

this purpose, even with a steep up-grade in the track east of the bridge, fixes the elevation of the draw higher than would otherwise be necessary. The bottom of the main girders is about 6 ft. above high-water, and the top of the pier masonry is about a foot lower.

In structure, the draw comprises four longitudinal plate-girders, one under each rail, tied together by a plate-girder end frame, intermediate sway frames, and between either pair of girders a top lateral system. The center and rest piers are of masonry. The cross-ties rest on the top flanges of the main girders. Except over the turntable, the ties extend only over one track width, only every fifth or sixth tie being carried all the way across the bridge (this is not correctly shown in the deck plan, Fig. 2). The third-rails on the draw are outside, and their insulators are carried on projecting long ties. On the abutment both third-rails are located on the inside, between the two tracks.

The arrangement of rails, rail-guides and guard-timbers is clearly shown in Fig. 2. The guard-timbers are set with the inner face 10 ins. from gage face of rail, the standard spacing on the Pennsylvania R. R. This leaves a clear space of one or two inches between guard-timber and third-rail insulator (the insulators are 10 ins. wide transverse to the track). About 5 ft. from the end of the bridge the third-rails terminate by cast-iron approach blocks.

The track rails on the draw are spiked down over the middle portion of the draw. The end lengths, however, are entirely loose; they are held longitudinally by the splice-plates at their inner ends, and laterally by a series of guide sockets. Their outer ends, as already noted, lap over onto the abutting trestle by about 2 ft., and form a bevel joint with the fixed rails on the trestle. The rails on the trestle and the spiked rails on the draw are provided with clamps F to prevent creeping; in Fig. 3 a detail of such a clamp is given. Eight of these clamps are provided for each rail, two on either abutment and four on the spiked length of rail on the draw.

The rail-guides require attention commensurate with the importance of their function. They are of different kinds, all detailed in Fig. 3. The movable rail, 29 ft. 4½ ins. long from splice-plates to scarf, is guided and held to gage at the scarf joint by a special form of guide A A′ which backs the outside of the rail-head with a solid steel block, in order to insure accurate alinement of fixed and movable rail-ends. This guide A is 3 to 3½ ft. long and extends to the edge of the abutment. The outer base-flange of both fixed and movable rail is cut back to flush with the side of the rail-head, over the length of the guides A and A′.

On the draw the short guides B and C and the long rear guide D are provided. These consist of a base-plate and two longitudinal angles riveted to it, one on either side of the rail, the upturned leg of the angle being in contact with the edge of the rail-base; they do not guide or support the rail-head. The long guide D has, in addition, a cover-angle riveted along the outer guide-angle for part of its length, which cover-angle reaches over the rail-base so as to prevent the possibility of the rail jumping (or being thrown) out of the guides.

The lifting of the movable rail out of the guides when the bridge is to be opened is accomplished by the rail-lift E, operated as will be explained below. This rail-lift is a 6-in. channel bar lying flat, flanges down, extending over the width of a single track only (because the presence of longitudinal interlocking rods between the tracks would not permit of lifting to the required height a channel extending all the way across the bridge). The rail-lifts of the two tracks are operated from a single crank-shaft. *The rail is not fastened to the lifting channel, but merely rests on it during the lifting.* When the bridge is closed and the rail-lift is down, there is in fact a clearance between the bottom of the rails and channel in the actual bridge (this seems to have been intended in the design, moreover, as it is indicated in the cross-section in Fig. 4). Thus, while the rail is lifted positively, it is not drawn down positively, but is merely allowed to drop into its guides by the lowering of the rail-lift channel E.

The rail-lifts are operated by the same mechanism which operates the wedges under the end shoes, and the end latch. The movement of this mechanism is under the control of a lock, located at L, Fig. 2, on the deck of the bridge at the joint between draw and abutment (but not shown in Fig. 2). This lock does not permit the wedges to be driven, the latch-bar to be dropped, and the rail-lift to be lowered, except when the bridge has been swung around into exact alinement with the fixed track.

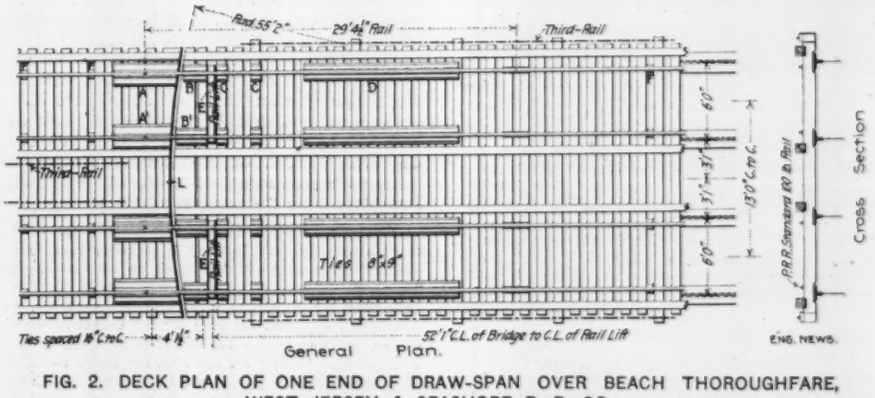


FIG. 2. DECK PLAN OF ONE END OF DRAW-SPAN OVER BEACH THOROUGHFARE, WEST JERSEY & SEASHORE R. R. CO.

[Though shown extending over all four tracks, the cross-ties in the actual structure extended over a single track width only, except that at intervals of 8 to 10 ft. a tie spanned the full width.
The bridge opens in clockwise direction, and closes in opposite direction.]

The operating parts of the end mechanism are shown in Fig. 4, and separate details of the end-shoes and wedges in Fig. 5. The operation of the mechanism is so clear that little in explanation is needed. A longitudinal worm-shaft drives the mechanism by means of a worm-wheel and its

shaft, and a series of connecting-rods. The cranks of the wedge operating shaft are so set as to give toggle action for driving home the wedge. Each of the two vertical rods which lift either rail-lift channel is secured to the channel by top and bottom nuts, and is guided by a hole

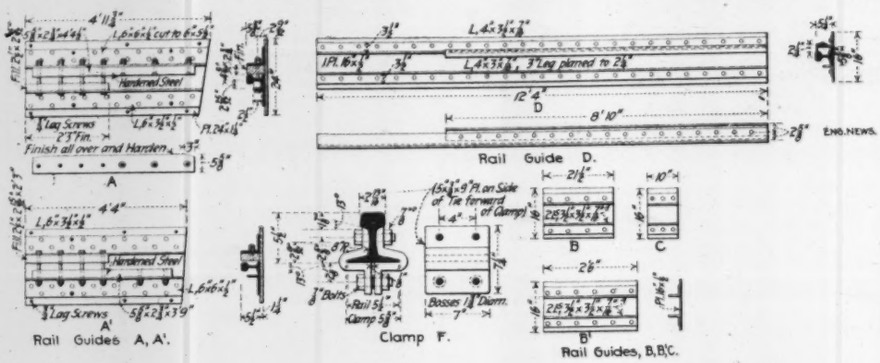


FIG. 3. DETAILS OF RAIL-GUIDES AND ANTI-CREEPING CLAMP.

in a horizontal plate riveted to the flange of the adjoining main girder.

The latch-bar is not shown in Fig. 4. It is a vertical 5 × 1-in. bar, placed with its face flat against the inner face of the end cross-girder, on the longitudinal center line of the bridge, and guided for vertical motion by several guide-brackets. At its lower end it is adapted to enter a recessed latch-plate casting bolted to the top of the rest-pier masonry. At its upper end the bar has a square hole, which is entered by the end of a crank (shown in Fig. 4) keyed to the shaft from which the rail-lift is actuated.

The lock which controls the movements of the end mechanism is not detailed in our drawings, but is illustrated by the diagrammatic sketch, Fig. 6, made at the site of the bridge by a member of our editorial staff. The lock-stand, mounted on the end of the draw, gives passage to a lock-bolt of about 1½-in. diameter; the lock-bolt is connected with the interlocking levers and prevents their moving the semaphore signal to clear, or allowing the motion of the end-operating mechanism, unless the lock-bolt is free to move forward into engagement with the lock-plate mounted on the abutment. A pendulum pivoted on the front of the lock-stand acts as ward to the lock; it is pushed aside by a pin projecting from the lock-plate, thereby clearing the lock. This clearing of the lock is completed only when the track on the bridge is in exact alinement with

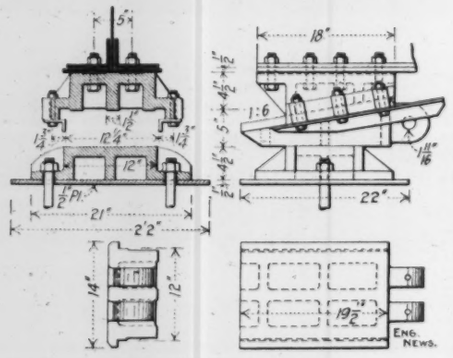


Fig. 5. Wedges and Shoes.

the fixed track. The lock may be seen on the left in the photograph, Fig. 1.

The bridge is turned by hand power only, for which three capstan heads are provided over the turntable, adapted to be turned by capstan-bars. Two of these serve to turn the bridge (one for fast, the other for slow motion), and the third operates the end mechanism. The bridge-tenders, who turn the bridge, were also required to inspect the scarf-joints of the track-rails after the bridge was closed, to make sure that they dropped into place properly in the guides; by removing a red flag which they put up at the end of the bridge before turning, they then signaled to the towerman who controls the semaphores that the bridge is ready for trains.

The semaphores are set about 200 ft. back of the trestle at either end, that is to say, about 400 ft. back of the draw. The signal tower is located at the east end of the trestle, 200 ft. from the draw.

THE TRANS-ALASKA SIBERIAN RAILWAY PROJECT.

As our readers will recall, a project has been for some time discussed in Paris and New York to build a railway line through Arctic Siberia to Bering Strait, and thence through Alaska to a connection with the Canadian railway system. The chief promoter of the scheme is Mr. Loicq de Lobel, of Paris.

An Advisory Board of Consulting Engineers has been created in connection with the enterprise, made up as follows: Mr. Edward A. Bond (President), Chairman of the Advisory Board of Consulting Engineers of the State of New York; Mr. Alfred Craven (Secretary), Member of the Advisory Board of Consulting Engineers of the Metropolitan Subway of New York City; Dr. J. A. L. Waddell (Principal Engineer), Consulting Engineer of Kansas City, Mo.; Mr. John Lyle Harrington, late Chief Engineer of the Locomotive & Machine Co. of Montreal, Canada; Mr. Liocq de Lobel (Promoter), General Delegate of the French and Russian Committees of the proposed Trans-Alaska Siberian Railway; and Dr. Elmer L. Corthell (Vice-President), Vice-President of the Advisory Board of Consulting Engineers of the State of New York.

A meeting of this Advisory Board was held in New York on Oct. 17, and it was decided to recommend that a preliminary survey of the main line and branches in Siberia should be made as soon as possible. The line will probably leave the Trans-Siberian Railway at Kabarovsk or Nicolaievsk or Okhotsk. These studies and surveys will be under the direction of Mr. de Lobel and Dr. Waddell, of the Advisory Board, the latter acting as Principal Engineer. The Board also adopted the following resolutions:

(1) That it recognizes that the construction of the Trans-Alaska Siberian Railway is perfectly feasible and without extremely great difficulties, in both Alaska and Siberia.

(2) That the enterprise is absolutely practicable, and that it will be useful not only for the United States and Russia, but also for all the countries in Europe.

(3) That, in its opinion, the company which undertakes the construction of this railroad will reap considerable pecuniary benefit therefrom, both on account of future traffic and especially because of the exploitation, or the renting, or the sale, of the rich minerals contained in the blocks of land granted the company by the Russian Government, and of which the estimated actual value far surpasses the greatest possible cost of the completed railroad.

(4) That, judging by the benefits resulting from the railroads thus far constructed in Alaska, it is safe to predict a brilliant future for the Trans-Alaska Siberian Railway.

(5) That in respect to the tunnel under Bering Strait, there do not appear to be any insurmountable difficulties in its construction. The Advisory Board of Consulting Engineers, however, reserves the right to make a report upon this portion of the work and its probable cost after a thorough examination of all the conditions has been made, either directly by it or under its auspices.

(6) The Board has decided to entrust to Dr. W. the preparation of a report to contain the conclusions of the meeting concerning the feasibility of the project, the difficulties that may be expected in the construction of the proposed railroad and tunnel. This report is to be addressed to the Organizers of the Preliminary Syndicate Co. of the Trans-Alaska Siberian Railway.

The route of the proposed railway in Alaska, as now planned, would be from Cape Prince of Wales along the coast to Port Clarence, passing about six miles north of Teller Mission. It would then follow Agiapak Creek to a point near its junction with Flat Creek, then would pass across the foothills to Mary's River, Winter Creek, and across the divide to Joe Creek; thence east to the junction of the Kugruth and Noxapaga Rivers; thence up the South Fork and across the divide to the headwaters of the Koyuk River, which stream it would follow down until near the head of Norton Bay; from there the line would ascend the valley of the Inglutalik River, thence over two small divides and river valleys to the Koyuk River, down which stream it would follow to the Yukon. The line would then follow the Yukon to the Tanana, and along the Tanana through Fairbanks and across a divide to the headwaters of Ladue Creek. This stream would then be followed to the Canadian border at a point about latitude 63° 18' north. A distance of 40 or 50 miles farther would probably intersect the proposed Canadian railway to Yukon. A branch would probably run from near Fairbanks to tide-water near the town of Seward.

The profitable business being done by the railways already built in Alaska is the ground for asserting that the proposed railway, making accessible valuable mineral deposits, would obtain a profitable traffic. In populous mining centers, like Fairbanks and Nome, a fire occurring during the winter might destroy the food supplies, in which case the people would starve to death. It is fear of this danger that causes about three-fourths of the population of Alaska to leave the country every year before the winter season. Were a railway in operation, supplies could be brought in continuously during the year, and this depopulation averted. The Russian Government has agreed to give to the Trans-Alaska Siberian Ry. Co. of New Jersey a grant of land consisting of blocks about 15 miles square, on both sides of the line of its road, alternating with similar blocks that remain the property of the Government. This grant is to be made as soon as the survey of the main line is completed, under certain conditions. The grant gives to the railway company all surface and mineral rights in

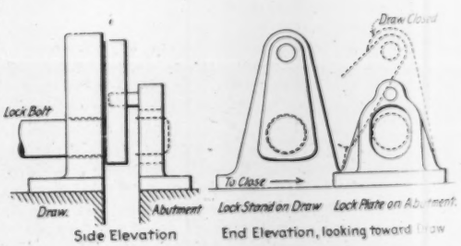


Fig. 6. Lock for End Mechanism (Diagrammatic Sketch).

these lands for a period of 90 years. The railway company has the privilege of so locating its line that it will pass through or near the richest mineral lands. It is the claim of the promoters that the values of the mineral deposits which the railway will thus acquire will make the enterprise a most profitable one. It is evident that before a final location can be made it will be necessary to make a thorough mineralogical exploration of the country, by expert geologists and prospectors.

COMPOSITE FIRE-BOXES OF COPPER AND STEEL.

Bad water and high steam pressures have for some time caused much trouble with copper tube-sheets in the locomotives of the Cologne division of the German railway system. The development of cracks in the sheet between the tubes took place so rapidly on this division that repair costs became excessive. At steam pressures near 180 lbs., patching is required in 10 to 12 months, as against two to three years on other divisions; at 210 lbs., a tube-sheet lasts only 4 to 6 months. No improvement was effected by increasing the spacing of the tubes or by varying the style of crown stays; nor does the width of the fire-box seem to have any relation to the growth of cracks. Fig. 1 herewith indicates the usual location of the cracks; they appear first in the upper five rows of the second vertical row of tubes, from the outside, and spread to the other rows lying toward the vertical center line. The cracks begin at the fire side of the sheet as fine cracks, but soon widen and deepen.

It was considered that the cracking was due primarily to the continual changes of shape of the boiler, under the combined influence of heat changes, pressure and motion, and that a material of higher strength than copper was required. Trials of soft steel fire-boxes, about ten years ago, had showed such rapid deterioration of the steel sheets in the fire zone as to make

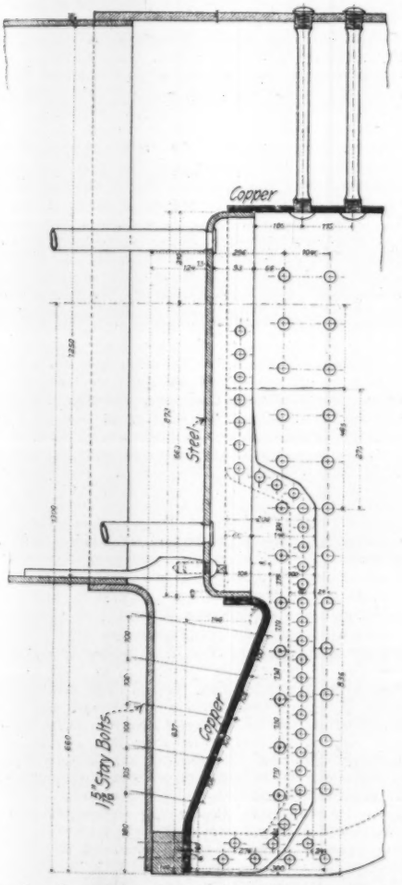


Fig. 2. Composite Front Sheet for Locomotive Firebox, as Applied at Cologne Repair Shops.

repair or renewal necessary in three to four months; at the same time the steel behaved excellently in all portions of the fire-box not in contact with glowing coal. More recently experiments were made as to the value of a copper-zinc-iron alloy, and a silicon-aluminum bronze, for tube-sheets and fire-boxes, but these materials did not prove satisfactory.

As a final solution, it was proposed by Mr. Mayr, of the division in question, to use a composite front sheet, comprising an upper part or tube-sheet proper of soft steel, and a lower part of copper. First proposed in 1896, this device could not be tried until four years later. Since then, two fire-boxes have been fitted with composite front sheets. The results have been very good, cracking is apparently done away with, and there is less tendency for leakage at the tube-ends. The holes for the tubes have copper ferrules 1/10-in. thick. The lower (copper) portion of the sheet is stayed with copper staybolts. The arrangement of the composite front sheet, as applied to the first engine, is shown in Fig. 2, taken from an article by Mr Mayr in the "Organ für die Fortschritte des Eisenbahnwesens." The steel tube-sheet is ½-in. thick, while the remainder of the fire-box consists of ⅝-in. copper sheets.

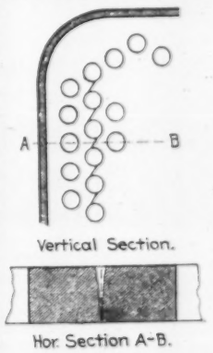


Fig. 1. Location and Type of Cracks in Copper Firebox Tube-Sheets.

A NEW REINFORCED CONCRETE HOTEL, under construction at Long Branch, Cal., collapsed Nov. 9, killing nine workmen and injuring many others. Five stories of the central wing fell, burying the workmen under the debris. The cause of the accident is variously stated, faulty construction, removing of supports before the concrete was properly set, etc. The hotel covered an area of 348 × 175 ft., and four stories had four stories had been completed. With reference to the published statement in Associated Press dispatches that the Trussed Concrete Steel Co., of Detroit, Mich., were contractors, we have received from that company the following information:

The building was originally designed and carefully detailed with twisted bars and contract let to F. S. Spalding, of Los Angeles, Cal. When the owner of the building observed some buildings of our system of hollow tile construction, he decided to use the same for his floors, and so instructed his contractor. In accordance with this, Mr. Spalding, the contractor, purchased from us the necessary bars for the floor slabs and beams, retaining the original design with twisted bars for the footings, columns, lintels and veranda floors. We have never had anything whatsoever to do with the construction of the building, nor has any one of the men directly connected with this company ever been near the building.

A FATAL RAILWAY ACCIDENT occurred on the Baltimore & Ohio R. R., near Woodville, Ind., Nov. 12, when an immigrant train running at 40 miles per hour, collided with a freight. The locomotives, six passenger coaches and several freight cars were thrown down a 10-ft. embankment and demolished. The wreckage immediately took fire and many of the injured were burned to death. Of the 165 passengers, 47 were killed and 38 injured, several fatally. The accident appears to have been due to a misunderstanding of orders by the freight train crew. The immigrant train was being run as the second section of a through Baltimore-Chicago train, and the freight crew evidently did not know or forgot there were two sections to the train, for, after the first section had passed, they left the siding and pulled out on the main track, colliding head-on with the passenger train on a curve.

A BROKEN RAIL wrecked a passenger train on the Baltimore & Ohio Southwestern R. R., near Blanchester, Ohio, Nov. 10, injuring a score of people, one of whom died later. The engine, postal and baggage cars passed over the rail in safety, but five coaches were overturned and rolled down an embankment.

A RUNAWAY FREIGHT ENGINE, in the yards of the Michigan Central R. R. at Detroit, Mich., on Nov. 12, partly demolished the Third Street Depot, killed one man and injured two others. The engine was switching in the yards, a mile from the station, when the crew saw a passenger train approaching, and, thinking a collision was about to occur, jumped, leaving the engine to run wild.

THE EXPLOSION OF A PASSENGER LOCOMOTIVE, attached to the Southern Pacific's Sunset Express, at Sargents' Station, Cal., Nov. 12, killed two men and fatally injured another, besides slightly injuring many passengers. The explosion demolished the depot, tore up the track for 100 ft. in either direction and overturned the first four coaches of the train. The sleeping cars, however, remained on the track.

A BOILER EXPLOSION at the power-house of the Lake Shore & Michigan Southern Ry. at Cleveland, Ohio, Nov. 12, resulted in the death of six workmen, and the serious injury of five others. The men were employed in building the foundation for an electric generator, close to the boiler, and were scalded to death by the escaping steam.

A "JACK KNIFE" DRAWBRIDGE, spanning Chelsea Creek at Boston, Mass., collapsed Nov. 3, and fell into the creek. The accident was due to the lifting connections giving a ay, which allowed the trusses to fall. The draw, over which pass the tracks of the Boston & Albany R. R. (N. Y. C. & H. R. R.), had been opened to allow a boat to pass through and had become fouled with some timbering underneath. It was while workmen were trying to close it that it collapsed. The trusses have been replaced on the abutments and the supporting rods are being repaired.

PERSONALS.

Mr. J. E. Carroll has resigned as City Engineer of Crookston, Minn.

Mr. Joseph S. MacLaughlin has been appointed Assistant Director of the Department of Public Works of Philadelphia, Pa.

Mr. Richard G. Doerfling, Engineer, and Mr. Fred W. Talbot, Engineering Aid, have resigned from the U. S. Reclamation Service.

Mr. A. J. Galvin, Assistant Engineer, in charge of sewer construction, Cleveland, Ohio, has resigned, and is succeeded by Mr. W. H. Henderson.

Mr. T. G. Golden has been appointed Superintendent of the Galveston Wharf Company's yards, at Galveston, Tex., to succeed Mr. R. H. Innes, resigned.

Judge William J. Leake has resigned as President of the Richmond, Fredericksburg & Potomac R. R. and the Washington Southern Ry., to be effective Nov. 19.

Mr. T. B. Dornin, of Newport News, Va., has been appointed Chief Engineer of the Water Department of Norfolk, Va., to succeed Mr. George W. Wright, resigned.

Mr. Richard L. Walker has been appointed Assistant to Mr. Vernon H. Brown, General Manager of the Cunard Line for the United States. He succeeds Mr. Robert Floyd, retired.

Messrs. R. Wilson Roberts and Marinus W. Terry have been appointed to the Board of Water Commissioners of Waterville, N. Y., to succeed Messrs. A. H. Weber and H. M. King, resigned.

Mr. W. C. Armstrong has been appointed Terminal Engineer, in Charge of Construction of the new Chicago Terminal of the Chicago & Northwestern Ry., with headquarters at Chicago, Ill.

Mr. Sam Lazarus has resigned as President of the Houston Belt & Terminal Ry. This company is building a belt line at Houston, Tex., which will connect with every railway entering the city.

Mr. H. Van Atta, for the past 15 years Superintendent of The J. L. Mott Iron Works, Mott Haven, N. Y., has associated himself with Mr. George K. Hooper, Mechanical Engineer, 11 Broadway, New York City.

Mr. Chas. K. Cooper, Chief Engineer of the Mutual Life Company's Buildings for 16 years, has resigned to become Consulting Engineer for the American Air Compressor Works, 26 Cortlandt St., New York City.

Mr E. P. Goodrich, M. Am. Soc. C. E., has resigned as General Manager of the Underwriters Engineering & Construction Co., of New York City, and has opened an engineering office at 1170 Broadway, New York.

Mr. George A. Berry, until recently Engineer of Company Forces of the New York Central & Hudson River R. R., has been elected Vice-President and General Manager of the Hicks Locomotive & Car Works, Chicago, Ill.

Mr. W. B. McLoughlin has been appointed Division Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., in charge of construction of the Evansville, Mt. Carmel & Northern Ry., with headquarters at Evansville, Ind.

Mr. Richard S. Buck, Consulting Engineer of the Bridge Department of New York City, has resigned, effective Dec. 31, to enter the employ of Sanderson & Porter, Contractors and Consulting Engineers, 52 Wall St., New York.

Mr. Ernest W. Wiggin has resigned as Assistant Bridge Engineer of the New York, New Haven & Hartford R. R., to accept the position of Engineer of Bridges and Buildings of the Missouri Pacific Ry., with headquarters at St. Louis, Mo.

Mr. H. A. Young, Assistant Engineer in charge of the Huntley Project, Mont., has resigned from the U. S. Reclamation Service, to become Chief Engineer in charge of the design and construction of a water supply system for Camaguey, Cuba.

Mr. W. H. Fredericks, formerly Traffic Manager of the Bethlehem Steel Co., has been appointed General Manager of the Ross Common Water Co., with offices at South Bethlehem. He succeeds Mr. Thomas O. Cole, resigned to become Car Service Agent for the Sea Board Air Line Ry., with headquarters at Portsmouth, Va.

Mr. H. W. Connell, Assoc. M. Am. Inst. E. E., has been appointed Assistant Superintendent of the H. H. Franklin Mfg. Co., automobile manufacturers, Syracuse, N. Y. Mr. Connell is a graduate of Smith College of Applied Science, Syracuse University, class of 1903, and was formerly employed by the Western Electric Co., Chicago, Ill., as an electrical engineer.

Mr. Frederick A. Goetze, M. Am. Soc. M. E., Superintendent of Buildings and Grounds, Columbia University, New York City, has been appointed Dean of the Faculty of Applied Science of Columbia University. He will assume his new duties Jan. 1, relieving Prof. G. F. Sever, who has been Acting Dean since the retirement of Professor Hutton as Dean on July 1, 1905. Mr. Henry Lee Norris, Assistant Superintendent of Buildings and Grounds, will succeed Mr. Goetze as Superintendent.

Mr. James T. Harahan has been elected President of the Illinois Central R. R., to succeed Mr. Stuyvesant Fish. Mr. Harahan started his railroad career as a switchman at Alexandria, Va., in 1864, later becoming a train dispatcher. In 1865 he was made Yard Master at Nashville, Tenn., of the Nashville & Decatur R. R. He was made Superintendent of the Memphis Division of the Louisville & Nashville R. R. in 1879, becoming General Manager of the whole system in 1884. In 1888 he was appointed Assistant General Manager of the Lake Shore & Michigan Southern Ry., and in 1890 became Second Vice-President and General Manager of the Illinois Central R. R.

Mr. Frederick Skene, the newly elected State Engineer of New York, was born at Garrison on the Hudson, but for the last 28 years has resided in Long Island City. He is a graduate of New York University, receiving his B. S. degree in 1896 and the degree of C. E. in 1897. Mr. Skene was appointed to the Queens County Engineer's Office in 1896 and became Assistant Engineer in the Bureau of Highways, Queens Borough, when it became a part of New York City. He has been in charge of the Engineer's Office in the Bureau of Highways since 1899, and is a member of the Municipal Engineers of the City of New York.

Obituary.

J. H. Springer, Jr., Bridge Engineer of the Louisville & Nashville R. R., died at Louisville, Ky., Nov. 4.

F. T. Robertson, formerly General Superintendent and Chief Engineer of the Montana R. R., died Oct 18, after two months' illness.

Michael Storms, founder and recorder of Colorado's first gold camp, now Central City, died at Denver, Col., Nov. 10, aged 83 years.

Cornelius Van Houten, Secretary and Treasurer of the Water Works Equipment Co. of New York City, died at his home in Newark, N. J., Nov. 8.

Lovel O. Gassett, formerly General Superintendent of Motive Power, of a portion of the Southern Ry., died at Cleveland, Ohio, Nov. 6, aged 73 years.

Thomas Kirkwood, founder and President of the Thomas Kirkwood Co., Sanitary Engineers, New York City, died at his home in Brooklyn, N. Y., Nov. 9, aged 64 years.

Albert H. Zeller, Assoc. M. Am. Soc. C. E., died at St. Louis, Mo., Nov. 2. Mr. Zeller was a graduate of Washington University, St. Louis, class of 1887. He was formerly employed by the Missouri Pacific Ry. as a civil engineer, and the Edgemore Bridge Works, Wilmington, Del.

John P. Wetherill died of Bright's disease, at his home in Philadelphia, Pa., Nov. 9, aged 63 years. Mr. Wetherill was one of the founders of the Lehigh Zinc Co., which was merged with the New Jersey Zinc Co. Until a year ago he was Consulting Engineer and a director of the New Jersey Company.

Edmund H. Miller, Professor of Analytical Chemistry at Columbia University, died at New York City, Nov. 8, of typhoid fever, aged 37 years. Prof. Miller was a graduate of Columbia and the author of "Quantitative Analysis for Mining Engineers," besides several other text books of a similar character.

John C. Welling, Vice-President of the Illinois Central R. R., died at his home in Chicago, Ill., Nov. 9, of pneumonia. He was born at Pennington, N. J., Feb. 24, 1840, and had been connected with the Illinois Central since 1874, first as Acting Secretary, then as Assistant Treasurer; later becoming Vice-President.

John L. Oberg, member of the firm of Oberg & Blumberg, Electrical Engineers and Contractors, 112 West 42d St., New York City, died at his home in Ridgefield Park, N. J., Nov. 8, of heart disease, aged 39 years. Mr. Oberg was born in Sweden, and educated at Stevens Institute, Hoboken, N. J. He was a member of the Electrical Engineers' Society of New York City.

Edward Fullerton Milliken, Vice-President and Director of Milliken Brothers, Inc., New York City, died at the New York Hospital, after an operation for appendicitis, Nov. 10, aged 44 years. Mr. Milliken had long been connected with the iron and steel business, having been admitted into partnership in his father's business in 1879. In 1887 he and his brother, Foster Milliken, took over the business and continued it until January, 1900, when the company was incorporated. He was formerly President of the company.

Wilhelm Ritter, for many years Professor of Graphic Statics and Bridge Engineering at the Zürich Polytechnikum, and prominent for many contributions to the analysis of bridge structures, died on Oct. 8, 1906, in his 60th year. Ritter was born at Liestal, near Basel, Switzerland, in 1847, and took the degree of Structural Engineer at Basel in 1868. In 1873 he was called to Riga as Professor of Engineering Science, where he remained until, in 1881, on the death of the famous Culmann, his former teacher, Ritter was called back to Zürich to continue Culmann's work. He worked here continuously until 1902, since which time he had been an invalid. Ritter's principal labors were in the field of Graphic Statics. He devoted himself to carrying forward the unfinished work of the founder of the subject, Culmann; in particular, he published, in 1888, 1890, 1900 and 1906 four volumes on Applications of Graphic Statics dealing respectively with internal stresses, trusses, continuous beams and arches.

Carleton Walworth Nason, M. Am. Soc. M. E., President of the Nason Manufacturing Co., 71 Fulton St., New York City, died at his home in New York, Nov. 4, of pneumonia. He was born at Woburn, Mass., in 1849, but two years later his parents removed to New York City, where had since been his home. His father, Mr. Joseph Nason, the inventor of the globe valve and the Nason steam trap, opened a branch office at New York, of the firm of Walworth & Nason, of Boston, of which he was a member. Later, the late Mr. Henry R. Worthington became a partner and the firm name was changed to Joseph Nason & Co. In the meantime Carleton W. Nason had entered the Schools of Mines of Columbia University, but at the age of 18 he left college and entered his father's office. In 1872, upon the death of his father, the firm name was again changed, becoming the Nason Manufacturing Co., and he was made Vice-President. Mr. Nason was an inventor of some note, having designed a wrought-iron boiler for house heating, a pneumatic lift, a wrought-iron pipe steam radiator, etc. Mr. Nason was the Chairman of a committee of the American Society of Mechanical Engineers, which had in charge the question of a schedule of standard flanges for pipes 2 to 48 ins. in diameter, and for pressures up to 200 lbs. The result of the work of this committee, in conjunction with committees from other societies and manufacturers, was adopted in 1884. He was also Manager of the American Society of Mechanical Engineers during the years 1889 to 1892.

Freeman C. Coffin, M. Am. Soc. C. E., of Boston, Mass., died at his home in West Medford, Mass., on Nov. 11, of kidney trouble, after a serious illness of ten days. Mr. Coffin was born in Boston on Sept. 14, 1856, but at the age of two years his parents removed to Patten, Me., where his early education, partly at Patten Academy, was secured. Engaging for a time in the furniture business in Patten, before he was twenty, he subsequently went to Boston and entered the employ of the Coffin Valve Co., Mr. Z. E. Coffin, the head of that company, being his uncle. In 1884 he took up engineering work. For many years Mr. Coffin was principal assistant to the late M. M. Tidd, of Boston. On Jan. 1, 1894, Mr. Coffin began independent practice. Although not confined to water-works engineering, Mr. Coffin's extensive practice of recent years was largely in that line. Among the water-works designed by him may be mentioned those at Charlottetown, P. E. I., Baton Rouge, La., and Vancouver, B. C. In 1897 Mr. Coffin published a book, entitled "The Graphic Solution of Hydraulic Problems." He contributed many papers to the New England Water-Works Association, some of the most notable ones being "Stand-Pipes and Their Design," "The Financial Management of Water-Works," and "Covered Reservoirs and Their Design." He did particularly notable work as a member of the Committee on Standard Specifications for Cast-Iron Pipe and Special Castings, the report of which was adopted by the New England Water-Works Association in 1902; and later Mr. Coffin also did important work as a member of a committee of the same association, on meter rates. He also contributed important discussions to the American Society of Civil Engineers, on "The Financial Management of Water-Works" and on "The Valuation of Water-Works Property." Besides being a member of the American Society of Civil Engineers and the New England Water-Works Association, Mr. Coffin was a member of the Canadian Society of Civil Engineers, the Boston Society of Civil Engineers and the Twentieth Century Club. He is survived by a wife and four sons.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 3-4. Annual Meeting at New York City. Secy., W. Everett Parsons, 12 Bridge St., New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 4-7. Annual Meeting at New York City. Secy., F. R. Hutton, 12 West 31st St., New York, N. Y.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 2, '07. Annual Meeting at New York City. Secy., L. O. Howard, Cosmos Club, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 3. Annual Meeting at Pittsburg, Pa. Secy., F. V. McMullin, 410 Pennsylvania Ave., Pittsburg, Pa.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 8-11. Annual Meeting at Chicago, Ill. Secy., Chas. C. Brown, Commercial Club Bldg., Indianapolis, Ind.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 9. Annual Meeting at Boston, Mass. Secy., Mr. Willard Kent, Narragansett Pier, R. I.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 16-17. Annual Meeting at New York City. Secy., C. W. Hunt, 220 West 57th St., New York.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The Nominating Committee has reported the following list of officers to be voted upon at the annual meeting in January: President, Mr. John C. Whitney, Newton, Mass.; Vice-Presidents, Messrs. M. N. Baker, New York City, Joseph M. Birmingham, Hartford, Conn., George H. Snell, Attleboro, Mass., Freeman C. Coffin, Boston, Mass., George A. King, Taunton, Mass., and H. T. Sparks, Bangor, Me.; Secretary, Mr. Willard Kent, Narragansett Pier, R. I.; Treasurer, Mr. Lewis M. Bancroft, Reading, Mass.; Finance Committee, Messrs. Arthur D. Marble, Lawrence, Mass., William E. Maybury, Braintree, Mass., and George Cassell, Chelsea, Mass.; Additional Members of the Executive Committee, Messrs. A. E. Martin, Springfield, Mass.; D. N. Tower, Cohasset, Mass., and George W. Batchelder, Worcester, Mass.; Editor, Mr. Charles W. Sherman, Boston, Mass.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The ballot which has just been sent out to members, gives the following names as nominees for the respective offices: President, Prof. F. R. Hutton; Vice-Presidents, Messrs. J. W. Lieb, Jr., P. W. Gates and Alex Dow; Managers, Messrs. A. J. Caldwell, G. M. Basford and A. L. Riker; Treasurer, Mr. W. H. Wiley. The annual convention will be held in the assembly rooms of the New York Edison Co., 44 West 27th St., Dec. 4-7. At the opening session Tuesday evening, Dec. 4, the President, Mr. Fred W. Taylor will deliver an address on "The Art of Cutting Metals." The Wednesday morning session will be given over to business, reports of committees and discussion of the above address. The Wednesday afternoon, Thursday and Friday morning sessions will be devoted to the reading of papers. Thursday afternoon there will be an excursion over the new electrically equipped lines of the New York Central & Hudson River R. R., followed in the evening by a reception at Sherry's 44th St. and Fifth Ave. Among the papers to be read are: "The Evolution of Gas Power," Mr. F. E. Junge; "Ferroinclave Roof Construction," Mr. A. E. Brown; "Ventilation of Boston Subway," Mr. H. A. Carson; "Mechanical Engineering Index," Prof. W. W. Bird and Prof. A. L. Smith; "Weights and Measures," Mr. Henry R. Towne, besides many other interesting papers.

ILLUMINATING ENGINEERING SOCIETY.—The November meeting of the New York Section of the society was held in the Edison Auditorium, 44 West 27th St., New York, Friday evening, Nov. 9. The usual number, about 45, were present. The new secretary, Mr. Preston S. Millar, stated in his report that the membership is now 850, an increase of 100 over that at the October meeting. The new chairman, Mr. A. E. Forstall, made a short address, in which he mentioned the advisability of appointing a committee in the near future to secure space for the society in the new engineering building. The following papers were presented: Location of Lamps and Illuminating Efficiency, by Preston S. Millar; Fixture Design and Location, by Major E. L. Zalinski, U. S. A.; and Fixture Location in Residence Lighting, by F. N. Olcott. The discussion of the papers presented threw but little additional light on the subjects. The principal matter brought up was the adaptation of the law of inverse squares to the light reflected by parabolic reflectors. Major Zalinski stated that this law does not apply to reflectors parabolic throughout, that for reflectors partially parabolic the law applies to the extraneous angles, but not to the axial or immediately adjoining angles, and that for ordinary conical and dome-shaped reflectors the law practically applies throughout the field but must be based on actual photometric measurements at different portions of the field. Some took exception to this statement but the majority of the members agreed with the views advanced by the Major.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, November 15, 1906.

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REVIEWS.

Carpenter's Experimental Engineering.

[Contributed.]

EXPERIMENTAL ENGINEERING AND MANUAL FOR TESTING.—For Engineers and for Students in Engineering Laboratories. By Rolla C. Carpenter, M. S., C. E., M. M. E., Professor of Experimental Engineering, Sibley College, Cornell University. Sixth Revised and Enlarged Edition. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5⅝ × 9¼ ins.; pp. 843; tables, diagrams and 335 text illustrations. $6.

This is a book of 843 pages. In the matter of size its pretensions to superiority need no champion, for there is hardly a manual dealing with methods of conducting engineering tests which approaches it in this particular. It treats of a wide range of subjects, entering about the whole field of qualitative and quantitative determinations required in engineering practice, and its pretensions in this respect also ought to satisfy the most exacting. The personal experience of the author in the various lines covered, not only as director of the mechanical laboratory of Sibley College, but also as a professional engineer in commercial testing, in which he has been engaged outside of the College, dates back many years, so that his writings on this subject should be looked upon as those of an expert. Added to these considerations, the present book is the sixth edition, and is the result of many revisions and additions by which, as the author states, with the aid of colleagues and assistants, he has brought the subject down to present-day requirements. It might be expected that a book with such distinguishing marks would be found a model in all that goes to make an engineering manual of this kind a thoroughly satisfactory piece of work, but this expectation is far from realized.

It is surprising, to begin with, that the work is not well edited. There may be noticed, first, the division into "Parts" and "Chapters." There are several general subjects considered, there being in all 25 chapters; but the only general division designated by number in the whole book is that headed "Part II.," and entitled "Methods of Testing Steam Engines." Two headings precede this, printed in the same kind of type, but neither one is numbered, and there is no "Part I.," "Part III.," nor any other numbered division. This omission might be charged to a mere typographical slip were it not for the subject matter contained in the division marked "Part II." Although headed "Methods of Testing Steam Engines," a perusal of the chapters which follow and which it embraces reveals not only methods of testing steam engines, which, by the way, is specifically confined to only one chapter, but also chapters on the heating value of coals, gas analyses, methods of testing steam boilers, the steam turbine, hot air and gas engines, air compressors, refrigerating machines, and various other subjects having no reference whatever to testing steam engines.

Again, Chapter XV., dealing with "Methods of Testing Steam Boilers" (Article 375), refers to the standard method "adopted" by the American Society of Mechanical Engineers, and to the 1899 Revision of the same, and follows it up, in the next sixteen pages, with a complete copy of the revised code of rules. Forgetting that the revision has once been announced in this way, a second announcement is made of the same fact on the next page but one. Forgetting once more what precedes, the statement is then added that the new code is given in the "Appendix to this volume." In reality, there is no Appendix at all, and the code referred to is given nowhere else in the volume excepting in the first part of this very chapter.

Still again, the author alleges in his preface that:

> The book contains in a single volume the principal Standard Methods which have been from time to time adopted by various engineering societies for the testing of materials, engines and machinery.

This statement does not conform to the facts, because the standard method of the American Society of Mechanical Engineers for testing steam and gas engines is omitted, and, what is worse, we find no reference whatever to this subject in any part of the volume. The author must certainly be familiar with it, for it has been before the public for the past four years, having been published in the Transactions of the Society for 1903. Considering its high character, and the completeness with which it deals with all the leading features of engine testing, its absence from the book, after what the author writes in the preface, is most noticeable.

In connection with the matter of standards, there is another instance of careless editing which ought not to be passed by. At the end of Article 433, following the reprint of the rules of the American Society of Mechanical Engineers for testing pumping engines, there appears the following statement:

> In the use of a system like the preceding, every precaution should be observed in the adoption of methods, as well as in taking observations. The water discharged by a pumping engine, for example, should never be obtained by computation from the measured dimensions of the pump and the observed number of strokes, but should be measured directly. A weir is commonly arranged for this purpose.

It would be impossible for water to be measured directly by the system referred to, for the system provides for measurement by pump displacement, and by no other means. If the author of the statement had merely glanced through the rules of the American Society of Mechanical Engineers, to which he refers, he would have been saved this contradiction.

These, and many instances in the same line which might be added, show a careless editorship that seems inexplicable in a teacher of young men, who should set an example for others to follow. Students of engineering should be taught, above all else, the value of methodical and careful literary habits.

One cannot go far in an examination of the work without being struck with the lack of discrimination which it exhibits as to the importance of some of the subjects treated. Based on the amount of space occupied, the subject of greatest importance in the steam engineering portion of the book is that entitled "Methods of Measuring Moisture in Steam," which covers no less than 52 pages, or a greater amount than any other single subject. In marked contrast to this, "The Method of Testing Steam Boilers," to which the testing of moisture is merely an accessory, occupies only 21 pages. As to the real importance of this subject, it may be noted that in practice many boiler and engine tests—possibly the largest share of those relating to commercial work—are made without any determination whatever of the quality of the steam, so that looking at the subject from the standpoint of ordinary practice it seems to be rather unimportant. Examining the matter closely, it appears that in the great majority of boiler tests where the moisture is determined the percentage found is very small, being seldom over 1% when properly measured—too small to justify this extended treatment. A careful reading of the text given in these 52 pages shows that much of it relates to antiquated calorimeters or consists of superfluous descriptions, which had far better be omitted, thereby reducing the chapter to a size commensurate with its real importance. On the other hand, it is noticed with some surprise, that, in spite of the evident purpose of the author to present a full exposition of the state of this particular art, no mention is made of one of the most prominent modern calorimeters, which has been before the engineering public for over ten years, a cut and description of which appears in the report of the Boiler Test Committee of the American Society of Mechanical Engineers.

Based on the numerical order in which the subjects are arranged, the one occupying the first chapter would seem to be the most important. This chapter is entitled Application of the Method of Least Squares." It refers to the errors of one kind or another in taking a series of observations on the same quantity, and shows how to use the "method of least squares" in determining the probable error of the arithmetical mean of the observations, or that of any single observation, as compared with that of the true value. Giving this matter the prominence of first place seems most unwise, for it produces an impression upon the student, or engineering reader, of its great importance, which every one knows is quite unwarranted. It is a matter which in practice is seldom brought into use in working up the results of tests, and its place would be more consistentiy the last chapter than the first.

A similar lack of discrimination is shown in the treatment of subjects themselves. In describing the different instruments or pieces of apparatus used for a given purpose, the plan usually followed is to place them all, good, bad, and indifferent, on the same footing, and leave the reader to judge how well any individual one serves its purpose. To be of real value, the information should be presented so that the reader could see at a glance which one is considered a standard appliance for its purpose, not only in the laboratory, but, what is of far greater importance, "in the field," and which of those described occupy a secondary place. In too many instances the author goes into the fullest particulars regarding appliances which happen to be in use at Sibley College, and leaves out of consideration those of equal, or even greater, interest to the public at large, with which the author may be unfamiliar; and, in these cases, the information given is little better than that of the ordinary trade catalogue. This is unsatisfactory to the reader, whether he be a student or a practicing engineer, for it is well known that, out of a number of machines or instruments, one is likely to accomplish everything required, while another may fall far short of so doing.

The criticisms thus far relate to some of the prominent defects of the book, which a superficial examination reveals. We may now consider more closely the treatment of the principal

subjects. Quite a complete exposition is made, in Chapters III., IV. and V., of the principles, formulas, machines and methods of testing as applied to "Strength of Materials." A prominent and valuable feature of the chapter describing the various testing machines is the illustration, by cuts, not only of the leading machines as built and used, but of skeleton diagrams showing their main characteristics and principles of operation. The chapter on "Methods of Testing," however, is not wholly satisfactory. It lacks illustration by means of original logs obtained while using the machines, and by photographic reproduction of specimens subjected to the various processes of test. Of the latter, there is not a single example. Such detailed illustrations of the actual work of testing are sometimes of far greater use as a means of instruction, and certainly of far greater interest, than any amount of descriptive matter. The study of such examples comes the nearest of anything to actual experience, which is the only final teacher. In this connection, it is surprising to find almost no reference to timber tests, although in the laboratory of a sister college they are considered a leading department of that class of instruction. It may also be noticed that in the treatment of the methods of testing steel plate and the standards employed, no reference is made to the standard specifications of the American Boiler Manufacturers' Association relating to plates of steam boilers, although those specifications form a most valuable contribution to this important subject.

The four chapters which follow, relating to lubricants, power measurement by dynamometers, pneumatic determinations and hydraulic measurements, cover an interesting field, and these subjects are fully treated so far as they go, but they have the same lack of illustration as has just been noted. No logs of observations are given in connection with the description of methods of testing in these different matters, and almost without exception no figures are given of any results obtained by the use of the different apparatus. It is most noticeable in these chapters, and this is true also of other parts of the book, that much space is given up to formulas. Not only are the equations given which show the results sought, but, the steps taken in working out the equations are, in many cases, carefully explained. The explanation of the theoretical side of these subjects, especially in the matter of working out formulas, is considered in too much detail. Space thus taken up could be much more consistently and profitably devoted to a fuller consideration of experimental features, which, in a book of "Experimental Engineering," should certainly predominate.

In Chapter XII., devoted to "Measurement of Temperature," one is sorry to find that the author holds erroneous views regarding the best pyrometers. His opinion is that "calorimeter pyrometers," of which the Hoadley pyrometer is a type, are the best, although confessing that he chooses them in spite of the inconvenience and loss of heat attending their use. He turns down the Le Chatelier electrical pyrometer with a mere cut, and does not even accord it a place in the index, or make it the subject of a single paragraph. He says that electrical pyrometers require to be handled by skilled electricians, and are of little practical use to the engineer. Those who have employed the Le Chatelier instrument will hardly bear out the truth of this extraordinary assertion.

Reference has already been made to Chapter XIII., dealing with calorimeters, but the subject must be referred to again to express astonishment that, in describing the throttling calorimeter, no mention is made of the necessity of a correction for radiation of heat from the body of the instrument. It does not require expert knowledge to see that radiation must make the apparent percentage of moisture, without correction, greater than the actual. That this statement is true is very easily proved by observing the effect of covering a Carpenter calorimeter of the kind shown in Fig. 201, or, if covered, the effect of uncovering it.

One of the most interesting chapters of the book is the fourteenth, on "Heating Value of Fuels" and "Analysis of Flue Gases." These are matters which are of great importance in the problem of the economical burning of coal. Unfortunately the treatment of this subject, like others to which allusion has been made, is marred by erroneous views. In speaking of gas analyses and determination of carbon monoxide (CO), the author says:

> Unless the temperature is very high, CO is found only in very small quantities and rarely exceeds 1%.

This is quite surprising, for it is unusual, to say the least, to attribute the presence of CO to high temperature. There is, however, a powerful factor in this matter which the author does not take into account. The practice of carrying thick fires, which is far from uncommon, will always produce CO, amounting to much more than 1%, and this occurs whatever the temperature. Besides, a relatively small percentage of CO represents a large actual loss in fuel. The author further says:

> Considering the difficulty of absorbing CO and the consequent errors that are likely to arise, it may be in general better to neglect it.

It is difficult to accept this statement, for the two premises are wrong, and consequently the concluding advice is hardly warranted. Holding these views, however, it is not surprising that in the article "Deduction and Computation from Flue Gas Analysis," the author gives no information as to how to compute the loss of heat represented by CO in the gases. Neither is it surprising, perhaps, that he makes so little reference to the "heat balance" in a boiler test report in which the CO loss is a feature, the whole reference amounting as it does to only 10 lines.

Chapters XVI. and XVII. give a very complete, and generally satisfactory, description of the various steam engine indicators in common use, and a discussion of the leading features of indicator diagrams. In this chapter, the author countenances the use of the three-way cock for indicator connections, but no mention is made of the fact that it leads to erroneous indications. It is discouraging in a book of this kind to see statements and careful directions about matters of almost infinitesimal importance, in which the reader will find that this book abounds, with no reference whatever, as in this case, to matters of real moment.

These two chapters lack one feature which would be interesting, and, doubtless, of considerable value. No illustrations appear showing the effect on the diagram of certain prescribed changes in the setting of the valves and eccentrics. The omission is quite marked when viewed by one who makes use of the indicator more for setting valves than for any other purpose.

The habit of the author in giving undue weight to matters of little practical importance is well illustrated in Chapter XVIII., headed "Methods of Testing the Steam Engine." This chapter covers in all 45 pages. Of these, 24 pages, or considerably more than half, are devoted to the so called "Hirn's Analysis," or the calorimetric method of engine testing. Although beautiful in theory and an excellent study for a student investigating all the transformations of heat which are supposed to be going on in the cylinders, it is a very long and laborious process, and, when finished, one who has carried it through has little more practical knowledge of the engine than he had before.

The next important chapter which calls for criticism is the one on "The Steam Turbine," Chapter XXII., in which there are only six pages devoted to brief descriptions of the three leading types of turbines used in this country, and only two pages to methods of testing. In view of the enormous changes in motive power which have been going on during the past five years, on account of the successful introduction of steam turbines, it is astonishing that the author should have devoted so little space to the treatment of this subject. As it stands, it is a mere apology, for much more complete information can be obtained from current engineering literature than is given here.

In Chapter XXIII., relating to hot air [illegible] gas engines, the author is again behind the [illegible] in making no reference whatever to [illegible] gas engines, which are so largely coming into use at the present time, either those [illegible] the pressure type, or those of the suction type.

Despite these rather damaging criticisms, it must be said in conclusion that the book has many features which make it a valuable addition to engineering literature. No volume of [illegible] nature and scope could be otherwise, for the mere cataloguing of instruments and machines used in testing, and of the different methods [illegible] for making tests, forms a valuable collection for purposes of reference. It is to be hoped that, in the next edition, the author will revise the book throughout, correct the errors, omit such descriptive matter and verbiage as is unnecessary, add to subjects which are incomplete and thus produce a model, not only as regards superficial pretensions, but also as regards real worth.

WAGES AND HOURS OF LABOR, 1890-1905. RETAIL PRICES OF FOOD, 1890-1905.—Bulletin 65, Bureau of Labor, July, 1906. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 368; two plates.

This useful publication follows and continues the lines of earlier ones from the same source and on the same subjects. The many tables of wages and hours of labor give statistics by occupation, geographical divisions, industries, cities, and also by selected occupations by States; some of the figures are for the years 1904-1905, only, and others for the 16 years 1890-1905. The classified figures on the retail prices of food are very properly included between the same covers as those on wages. As many people know more or less definitely and to their sorrow, "the retail prices of food in 1905 were at the highest point during the 16 years 1890-1905." A total of 30 articles of food are considered in some detail, and the report states that when each of these "is given a weight according to its consumption in the family of the workingman" the advance in food prices "has been 0.6% since 1904, 17.7% since 1896, and 12.4% when compared with the average for the ten-year period 1890-99." Of the wages per hour in the most important manufacturing and mechanical industries of the United States, it is said that there was an advance of 1.6% in 1905 over 1904. The average time worked per week was the same in 1905 as in 1904, but 6.3% more persons were employed in the establishments investigated in the latter as compared with the former year. The average wages per hour in 1905 were 18.9% higher than the average for the ten years 1890-99, inclusive.

COMMISSION OF GAS AND ELECTRICITY OF THE STATE OF NEW YORK.—First Annual Report, Feb. 12, 1906. Albany, N.Y.: Pub. Doc. Cloth; 5¾ × 9¼ ins.; pp. 340.

Besides the reports on applications of various sorts for authority to issue bonds, and the like, this report gives summaries of statistics relating to gas and electric lighting in the State; prices charged for lighting; detailed reports from private and municipal gas and electric companies; and extensive forms to be used in making reports to the Commission in 1906. The detailed reports relating to individual lighting plants include a considerable range of information regarding the history and capitalization of the various companies and the extent, character and price of services rendered.

THE CONSTRUCTION OF SAND-CLAY AND BURNT-CLAY ROADS.—By William L. Spoon, Road Expert, Office of Public Roads. Bulletin No. 27, Office of Public Roads. Logan Waller Page, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 19; four plates and five text figures.

There are briefly discussed in this bulletin the physical properties of sand and clay, the proportioning and mixture of materials for the construction of sand-clay roads, the construction of such roads upon sandy and upon clay subsoils, respectively, and the cost of construction; also, the burning of clay for use in road-making, and the construction and cost of roads made of this material.

A Revised Edition of Buel and Hill's Reinforced Concrete.

Reviewed by Arthur N. Talbot.*

REINFORCED CONCRETE.—Part I.: Methods of Calculation. By Albert W. Buel, C. E., Engineer in Charge of Structural Designing and Technical Work in the Office of Virgil G. Bogue, Consulting Engineer. Part II.: Representative Structures. Part III.: Methods of Construction. By Charles S. Hill. Second Edition, Revised and Enlarged. New York: The Engineering News Publishing Co. Cloth; 6 x 9¼ in.; pp. 499; numerous illustrations; tables. $5, net.

In the two years which have elapsed since the first edition of this valuable book was issued, the interest of the engineering public in reinforced concrete has not lessened and the usefulness of a good book on this subject has materially increased. It is significant, also, that although the revision of the text was undertaken nearly a year ago, the authors found the task a long one and intended purchasers have had to wait some months for its appearance. A further indication of the growth of reinforced concrete and consequent changes in views and practice lies in the publisher's promise that subsequent editions of the book will be kept up to date. The second edition contains 65 pages more than the first, and many pages of the old text have been cut out and replaced with new matter. This is true especially of the part on Methods of Calculation.

For the benefit of those who have not seen reviews of the first edition, the scope and make-up of the book will be described. Part I., containing 155 pages, derives or states and discusses formulas and methods of calculation for beams, columns, arches, retaining walls, conduits, etc., and gives experimental data on beams and columns. Part II. (196 pages) describes and illustrates forms and types of structures which have been erected and gives examples of American practice in design. Part III. (105 pages) describes the various forms of reinforcement and the methods of construction used in foundation work, building work, bridge work and conduit work, together with something concerning the fabrication of the concrete itself. The three appendixes give data of tests of reinforced concrete beams and columns and a method of proportioning the ingredients in concretes.

Part I. has been materially modified, and errors which had crept into the first edition have been eliminated. The author's formula for the resistance of beams uses the moment of inertia of the section, but this form of expression, while of course rational, does not seem as convenient for use as the form which merely multiplies the tensile or compressive force by the moment arm of the couple. Several other beam formulas are given. The author does not propose any method of calculating web stresses or of proportioning stirrups or other web reinforcement, though he quotes a method of analysis for horizontal and vertical shear and diagonal tension. The values given for shearing strength of concrete on pages 6 and 7 are very low, and no reference is made to the higher results of Feret and other investigators. In fact, the statements about shearing resistance in beams given in two places are inconsistent. Again, to base the factor of safety in tension upon the ultimate strength of the steel used in the reinforcement and then state that failure of the beam in such cases will occur soon after the elastic limit of the steel is reached seems to lack agreement. The arguments for basing calculations on working stresses, given on page 45, do not seem sound. Many data of tests of beams from several sources, made in the last two years, are given, though there is little attempt at assimilation or coordination. The data on columns, including those of Appendix B, Watertown Arsenal Tests of Reinforced Concrete Columns, 1904, 1905 and 1906, cover considerable important ground, and the treatment of Considère's results and the discussion of Considère's formula for hooped concrete columns are good. The addition to the chapter on arches of an explanation of the construction of the polygons will be helpful to some readers, though the treatment was already fairly satisfactory. The location of the neutral axis at the middle of the section in the calculation of wind stresses in chimneys is likely to give considerable error. On the whole, Part I. is improved by the revision. If one were to offer a criticism, it would be that the treatment lacks unity, and that for the purposes of the general reader the extracts and quotations might well be replaced by a more unified presentation, in which, of course, different points of view would be included. The author may have had something of this in mind, when he expressed in the preface his hope to improve this treatment in future editions. It would seem, also, that the bending moments and stresses in floor slabs, the bending moments and stresses in conduits, the conditions and uncertainties of continuity in beams, and the bond stresses developed when reinforcing bars are carried from the bottom to the top of the beam are subjects which may well be included in Part I.

In Part II. the treatment of floors has been modified and improved, and some additions made in other ways. As before, this collection of some two-hundred reinforced concrete structures—foundations, piles, floors, beams, columns, walls, roofs, arches, culverts, tunnels, conduits, tanks, reservoirs, dams, and chimneys—is a valuable compendium of information, and cannot fail to be helpful and stimulating to the designer. It must be remembered that the plans are not critically discussed and naturally the collection includes some poor designs. Part III. has not been revised very thoroughly, as is shown by the retention of the old forms of corrugated bars and the older form of Kahn bar. However, Part III., as before, contains much matter of practical value: arch centers, forms, falsework, methods used during construction, and special provisions and precautions. Appendix A contains extracts from Bulletin No. 4 of the Engineering Experiment Station of the University of Illinois. Appendix B, Mr. Howard's paper on column tests, has already been mentioned. Appendix C contains Mr. Dana's paper on the Proportions of Ingredients in Portland Cement Concrete.

The book retains the excellent features of the first edition. The index is good. In much of the new matter, specific references to the original or to other sources of information have been inserted. The earlier edition was favorably received by engineers, and the new edition ought to grow in favor. In the field it attempts to cover this book should rank among the standard books and should continue to be of service to designer, constructor, and general reader.

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ATTRITION TESTS OF ROAD-MAKING STONES.—By E. J. Lovegrove, M. Inst. C. E., Borough Engineer and Surveyor of Hornsey. With Petrological Descriptions by John S. Flett, M. A., D. Sc., F.R.S.E., Petrographer H. M. Geological Survey, and J. Allen Howe, B. Sc., Curator and Librarian of the Museum of Practical Geology. London, England: The St. Bride's Press, Ltd. Cloth; 8¼ x 11¼ ins.; pp. xix + 80; tables, and 79 illustrations in the text. 5s. net; American price, $2.

Even though these studies relate chiefly to specific rocks in Great Britain, yet they contain considerable information of general interest. Mr. Lovegrove began making tests of "road stones" from various quarries in 1895. He was instrumental in arranging with the Geological Survey of Great Britain for petrological tests of road-making stone.

After a few paragraphs outlining the character of his investigations, Mr. Lovegrove submits tables giving attrition tests from a large number of quarries and a considerable variety of stones. The tests were made in iron cylinders provided with interior ribs, and in each case the percentage of chips and of dust, with the material dry and with it wet, was recorded. The table also indicates whether the stone was broken by hand or machine, and the specific gravity of the stone. The petrological descriptions are classified by granite, porphyry, basalt and other groups, and are accompanied by photomicrographs. The descriptions are also supplemented by general conclusions.

ELEMENTS OF MECHANICAL DRAWING.—In Two Parts. Part I. For Beginners: Exercises in the Use of Instruments and Use of Scales, and Simple Problems in Projections, Intersections, and Developments. Part II. Problems in Descriptive Geometry. By Alfred A. Titsworth, M. Sc., C. E., Professor of Civil Engineering and Graphics in Rutgers College. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 9¾ x 7 ins.; pp. 130; numerous illustrations in the text. $1.25 net.

But little originality is to be expected in text books on this subject. The present volume presents a few new designs for practice, and its mechanical make-up is unusually neat. The illustrations have been reproduced by the wax process exclusively, and in a few instances show faulty execution.

BRAZING AND SOLDERING.—By James F. Hobart. Being No. 5 of a Series of Practical Papers. New York: The Derry-Collard Co. Paper; 5½ x 8 ins.; pp. 33; 15 illustrations in the text. 25 cts.

Complete instructions for doing all kinds of hard and soft soldering, "sweating" and brazing, are given in this pamphlet, together with a short discussion of the theory of these processes. The tools required to do this kind of work are also described, and the proper flux to use noted.

THE MINERAL INDUSTRY.—Its Statistics, Technology and Trade During 1905. Founded by Richard P. Rothwell. Edited by Walter Renton Ingalls, M. Am. Inst. M. E., etc., Editor of the Engineering and Mining Journal. Vol. XIV., Supplementing Vols. I. to XIII., New York and London: Engineering and Mining Journal. Cloth; 6¼ x 9¼ ins.; pp. 739; illustrations and tables. $5.

The well-known lines of the 13 previous volumes have been followed in the one now before us. The general plan of the work is to give for each mineral or metal a general account of the industry and output for the year, following this with a section, sometimes illustrated, on progress in the metallurgy of the material treated. There are 51 contributors in this volume. The section on "Cements" was written by Mr. Robert W. Lesley, Vice-President of the American Cement Co., and that on "Progress of the Metallurgy of Iron and Steel" by Prof. Bradley Stoughton, of the Columbia School of Mines. An introduction of ten pages summarizes the statistical portions of the work.

COMPLETE EXAMINATION QUESTIONS AND ANSWERS FOR MARINE AND STATIONARY ENGINEERS.—A Complete Engine Operator's Catechism. By Calvin F. Swingle, M. E., Author of "Twentieth Century Hand-Book for Steam Engineers and Electricians," "Modern Locomotive Engineering Hand-Book," etc. Chicago, Ill.: Frederick J. Drake & Co. Flexible leather; 4½ x 7 ins.; pp. 367; 212 figures in the text and 1 plate. $1.50.

In this little volume the author has endeavored to provide information in catechetical form that will cover the details relating to the operation of modern stationary and marine steam plants. The questions that have been asked by municipal and government examining engineers of applicants for licenses as engineers and of persons having charge of steam boilers, constitute a considerable portion of the 800 queries contained in the book. The answers are, for the most part, concise, explicit, and well worded. The illustrative feature is also commendable in clearing up misty points and impressing the answers upon the mind of the reader. The book is indexed but contains no table of contents. The omission of the table of contents might be excusable if the index covered the subject more thoroughly. There are, however, only about 400 subjects indexed, so the oversight is quite a serious one when the book is used for reference.

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The Theory of Masonry Arches.

Reviewed by Wm. Cain.*

SYMMETRICAL MASONRY ARCHES.—Including Natural Stone, Plain-Concrete, and Reinforced-Concrete Arches. For the Use of Technical Schools, Engineers and Computers in Designing Arches According to the Elastic Theory. By Malverd A. Howe, M. Am. Soc. C. E., Professor of Civil Engineering, Rose Polytechnic Institute. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 170; 4 plates, 29 text figures, and many tables. $2.50.

Professor Howe has previously given us an able and comprehensive "Treatise on Arches" (New York: John Wiley & Sons), and has thus raised expectations, relative to his treatment of masonry arches, which this volume realizes. The book is a strong, sound handling of a difficult subject, leading to practicable methods for testing the design of an arch and incidentally for designing.

In the first chapter, fundamental formulas for the elastic arch are derived; in the second chapter, symmetrical arches without hinges and of constant or variable section, are considered. Formulas are derived for the horizontal thrust and moment for any point of the arch when subjected to either vertical or horizontal loads or temperature changes. The formulas apply to single loads and thus enable the computer to ascertain eventually the position of live load causing maximum moment at a point of the arch.

Considerable use is made of the theory of symmetrical loads, particularly in deducing the formulas for horizontal thrust for single loads and in abridging the tedious summation work in other cases. The effect of the axial stress for vertical loads is likewise considered, though this is rarely included in the design on account of the uncertainty of various preliminary data, which renders ultra refinement superfluous.

The formulas are valid for any division of the axis of the arch ring, though the author, in his examples, divides the arch ring neutral-axis into twenty *equal* parts and sums up the effect of the bending of each in proper tables. In fact, throughout the book, the approximate summation method is used and integration (which involves a division of the neutral axis into an indefinitely great number of parts) is not resorted to; integration is generally impracticable for the arch of variable section.

The one criticism that can be made of the theory developments in the book is that they are a little too condensed. A few notes here and there would smooth the beginner's pathway. The author carefully notes that m_x is used in one sense for horizontal thrusts and in another for moments. It would be well to write the formulas for m_x for $x = a$, and $x < a$, as well as for $x > a$, to avoid possible uncertainty, though the results are so easily implied. Perhaps, too, the first two formulas on p. 12, had best be written, considering magnitudes, as

$$H_1 = h_1 - h_2;\ Q = h_1 + h_2,$$

leading to the same formulas.

In Chapter III. the author applies the theory in detail to a segmental circular arch of constant section and also to a reinforced-concrete arch. In the second solution of the latter, the author has devised some notable simplifications, which shorten the work materially. The work for single loads at each point of the arch is long at best and the devices for reducing it to a minimum will be thoroughly appreciated. This work has been so well done that it is hoped the method of single loads may come more into favor, particularly for finding that loading which causes maximum stresses at the critical joints.

The author finds, for the reinforced-concrete arch (essentially the same structure which the reviewer treated in "Theory of Steel-Concrete Arches and Vaulted Structures"), that the maximum live-load stress at point 1, next the abutment, occurs for a uniform live-load covering about ⅜ of the span of the center line of arch ring (measured from the abutment), giving compression in the lower fiber, tension in the upper. When the live-load covers the balance of the span (only), the stresses are a maximum of an opposite character. Strictly, it will be found that a live-load at point 8, although it gives a moment at point 1 of an opposite character to loads at points 1-7, will cause only compression on the joint, so that the maximum compression there is a little greater when load 8 is included. Such refinement, though, may well be omitted by constructors, who, however, should note the above conclusions. On going about ⅔ the distance from abutment to crown (to point 7), the live load should cover first, about 0.4 the span and afterwards the remainder of the span, for stresses of opposite character at point 7. If computers then decide, for similar arches, to try only two positions of the live load for approximately the maximum stresses at the abutment or at point 7, the load may first be conceived to cover three-fourths of the span. The conclusions are nearly the same for the circular arch of constant section.

With regard to temperature changes, the author makes the important statement that "a recording thermometer placed in the ring of a reinforced-concrete bridge having earth filling, indicated that the total range of temperature change did not exceed about 20° F. in some ten or twelve months."

The last chapter of the book is devoted to drawings of typical arches. An appendix is given on the physical properties of stone and concrete and data for about five hundred masonry arch bridges.

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ECONOMICS OF ROAD CONSTRUCTION.—By Halbert Powers Gillette. Second Edition, Enlarged. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 49; nine illustrations in the text. $1, net.

About eight pages have been added to the first edition, in order to include articles contributed to this journal a few years ago on repairs and maintenance of roads, and suggested improvements in road specifications; the suggestions being based on clauses in the "Standard Specifications" for New York and Massachusetts, as published at the time.

SEWERAGE AND SEWAGE DISPOSAL.—By Prof. Henry Robinson, M. Inst. C. E., M. Inst. M. E., M. Inst. E. E., Author of "Hydraulic Power and Hydraulic Machinery" (Second Edition). London, England: Biggs & Co. Cloth; 5½ × 9 ins.; pp. 208; 40 tables and 1 folding diagram. 7s. 6d.; American price, $3.

The aim of the author was to present "a concise summary of the most important data" on sewerage and sewage disposal. The data, naturally, are chiefly from British sources. The value of the book, as compared with others on the subject, lies chiefly in its brevity and in its embodiment of some of the experience of the author. It contains chapters on house drainage, formulas for sewage flow, trades' wastes, disposal into the sea and the various methods of sewage treatment. A large folding diagram is inserted for the presentation of a sewage flow diagram for brick sewers.

DARSTELLUNGEN AUS DER GESCHICHTE DER TECHNIK DER INDUSTRIE UND LANDWIRTSCHAFT IN BAYERN.—Souvenir of the Technical College at Munich, at the Centennial Celebration of the Assumption of Royalty by Kurfürst Maximilian IV. Joseph, of Bavaria. Munich and Berlin, Germany: R. Oldenbourg. Paper; 9¼ × 11½ ins.; pp. xv. + 323; folding and other plates, and many text illustrations; four large folding sheets in pocket. 25 marks; American price, $10.

The contents of this well-written volume, in which over a score of persons contribute chapters, are in large part of purely local interest. The title "Passages from the History of Industrial and Agricultural Science in Bavaria" indicates, however, that those who like to delve in engineering history will find much information in the work. There are twenty chapters on special phases of engineering, industry and agriculture, the subjects ranging from Sanitation in Bavaria at the beginning of the 19th Century to the Brewing Industry, and Animal Husbandry. Bridges, locomotives, railways, geodesy, lighting, ceramics, etc., etc., are represented.

AMERICAN STATIONARY ENGINEERING.—Facts rules and general information gathered from thirty years' practical experience as running, erecting and designing engineer. By W. E. Crane. New York: The Derry-Collard Co. Cloth; 5½ × 8 ins.; pp. 285; 107 illustrations in the text. $2.

The author discusses in a very clear manner the defects usually found in boilers, engines, steam pipes, pumps, and accessories, and notes the remedies that have been devised to overcome them. The book is, in fact, a recount of his experience with such machinery, and should prove useful to stationary engineers, machinists and others who wish to know how to make engines, boilers, etc., operate correctly, and how to remedy defects in them when they appear.

In connection with the boiler, the author discusses firing, draft, coking and feed water, as well as boiler feed pumps, boiler scale, boiler settings, grates, and the cause and prevention of boiler leaks and explosions. The selection and installation of steam and exhaust pipes, so as to prevent leaks, water pockets, etc., is also considered. The best foundation for an engine, and the proper manner of constructing it, is noted, as are also the advantages and objections to different types of engines. The weak and strong points of different designs of engine details are discussed, while some space is given to valve setting, air pumps and condensers. The book is concluded with notes, rules and tables of useful information.

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Electrical Books.

Reviewed by Henry H. Norris.*

POLYPHASE CURRENTS.—By Alfred Still, Assoc. M. Inst. C. E., M. I. E. E., Author of "Alternating Currents and the Theory of Transformers." London, England: Whittaker & Co. (New York: The Macmillan Co.) Cloth; 4¾ × 7½ ins.; pp. 352; 110 illustrations in the text. $2.50.

ELEMENTARY PRINCIPLES OF CONTINUOUS-CURRENT DYNAMO DESIGN—By H. M. Hobart, M. Inst. E. E., M. Am. Inst. E. E. London, England: Whittaker & Co. New York: The Macmillan Co. Cloth; 8 × 5¼ ins.; pp. 220; folding and other tables; 106 illustrations, partly in the text. $3.

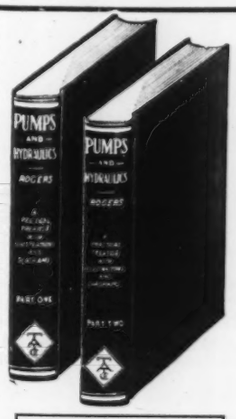
The Specialists' Series, to which these volumes belong, is well known for many excellent works on engineering topics, a number of which may be said to be standard. These recent works are consistent with the reputation of the series and they both form additions to electrical literature, although in entirely distinct fields. Mr. Still's book contains little that is novel in material or treatment. Its merit lies in a simple direct style and in the systematic arrangement of topics. The subject is one which is difficult to discuss without elaborate mathematical proofs, but the author has apparently succeeded in accomplishing this. The theory of the different devices is given in a descriptive style with curves, wiring plans of circuit, and vector diagrams as illustrations. Only occasionally and when absolutely necessary is a formula employed, and then it is of the simplest form. There is very little matter describing machines and other devices, as the reader is assumed to possess a practical knowledge of these obtained from everyday experience.

As would be expected, a large part of the book deals with the functions and properties of the power transmission line. As preliminary to this the usual elementary definitions and conventions are given. In connection with the main topic, brief mention is made of the peculiar features of polyphase alternators and transformers. As these do not differ materially from the single-phase types they are not treated in detail. The transmission line, however, is given a fairly exhaustive analysis as far as the essential elements are concerned. The writer wisely refrains from introducing unnecessary refinements, which are the delight of mathematicians, but which do not affect the results to an appreciable degree. He introduces, however, those engineering and economic problems, the correct solutions of which are necessary for the satisfactory operation of the system. These comprise the electrical losses in the line, the regulation of the electrical pressure, Kelvin's law for the most economical size of conductor and other practical topics.

The concluding third of the volume is devoted to the induction and to the synchronous motor, including the rotary converter. As these machines ordinarily form the receivers for a large part of the electric power transmitted they are appropriately included. The latest types of these motors are mentioned and the principles underlying their operation are briefly treated. Very little is said of the construction of the machines, this being outside the scope of the work.

In viewing the book as a whole, it impresses one as a reference text which will be very useful to the operators of electrical machinery who desire to know something of the theory of their machines, but who are not prepared or inclined to pursue the subject exhaustively. They will here find explanations of phenomena which would otherwise puzzle them, and they should be able to maintain their apparatus at a high standard of efficiency. The importance of the subject treated is indicated by the number of volumes devoted to it. Among similar books of recent appearance are Hay's "Alternating Currents," Smith's "Practical Alternating Currents," Abbot's "Electric Transmission of Water Power," and Bell's "Electric Power Transmission." The standart texts on the general subject are undoubtedly Steinmetz's two important books entitled, "Theoretical Elements of Electrical Engineering" and "Alternating Current Phenomena." These works are highly mathematical in nature and the others mentioned will serve as introductory to the more rigid and theoretical analysis of Dr. Steinmetz.

*Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.



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Mr. H. M. Hobart, who is a practical designer of large experience, is making a specialty of producing first-class text in the line of his chosen specialty. His writings are standard and they are characterized by a practical style and by great wealth of technical information. The present book is a model of its class and it is especially adapted to the use of students or others who desire a working knowledge of design practice. Obviously the subject of design is not one that can be taught entirely by means of a book, but at the same time the beginning of a knowledge of design may be made by this means, such knowledge to be supplemented by a careful study of successful machines. The author has had clearly in mind the necessity for constant practice on the part of the beginner in making elementary calculations, in order that facility may be acquired. The student is assumed to have a reasonable familiarity with the underlying principles of electricity and magnetism, and he should also possess some working knowledge of the machines used for generating continuous current. With this preparation the study will be easy and interesting if the author's method is systematically followed.

The salient feature of the book consists in the development of eighteen designs covering a wide range of practice. These designs are taken up by easy stages, the calculations for the entire line being subdivided into a number of separate sections. For example, the student is first asked to calculate the relation of the generated electromotive force to the magnetic flux entering the armature in each of the eighteen machines. He thus becomes familiar with the relative values of these quantities in generators of different sizes. Next the calculations of resistance and resistance drop are made, and these are followed by estimates of commutator and brush losses. This method is followed until by the time the study is complete the student has worked out all the details of the entire line of machines. Incidentally and at the proper points are introduced many practical matters bearing upon the general subject, and suggestions as to dimensions and proportions are made. The illustrations are of great assistance in connection with the text, as they familiarize the student with the interrelation of numerous variables, which relations are shown largely in graphical form. No particular mathematical knowledge is required aside from a high school training in algebra.

The subject of commercial design is to a large extent empirical, requiring trained judgment for the proper proportioning of the elements of the machines. The costs of material and manufacture are very large factors in determining these proportions, and such knowledge is beyond the reach of others than skilled designers. At the same time, design involves the judicious application of certain elementary laws and the study has value from this standpoint. It is difficult to see how the matter could be presented more clearly than in this book by Mr. Hobart, which will not only be useful to students, but will also serve as a reference work for practicing engineers, for the reason that it contains a large number of data taken from the author's experience. The reader is frequently referred to other texts dealing more thoroughly with certain aspects of the subject, especially with that of commutation, which is the most difficult feature of continuous current dynamo design. The mechanical features of the book are excellent, as the type is large and clear and the illustrations simple and well engraved. All of the calculations are carefully tabulated for reference, and the whole work is elaborately indexed.

A TEXT-BOOK OF ELEMENTARY ANALYTICAL CHEMISTRY.—Qualitative and Volumetric. By John H. Long, M. S., Sc. D., Professor of Chemistry and Director of the Chemical Laboratories in the Northwestern University Medical School. Third Edition; revised and enlarged. Philadelphia, Pa.: P. Blakiston's Son & Co. Cloth; 5 × 8 ins.; pp. 299; ten illustrations in the text. $1.25, net.

The present edition of this text-book for laboratory use has been enlarged at several points, including a chapter discussing reaction in solutions, and an addition of descriptions of a number of new processes at various points throughout the book. Seven groups of metals, acids, organic substances and examinations for poisons are taken up in Part I., on "Qualitative Analysis," while Part II., on "Volumetric Analysis," deals with various processes and also the analysis of specific materials, such as sugar and formaldehyde. A chapter of 17 pages is devoted to sanitary water analyses.

INSTRUCTIONS TO ENGINEERS OF TIMBER TESTS. By W. Kendrick Hatt, Ph. D., Civil Engineer, Forest Service. Circular 38. Forest Service: Gifford Pinchot, Forester. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 55; illustrated.

We doubt whether there have ever before been published such detailed instructions for making timber tests and recording the results obtained. Aside from the textual instructions, appendixes give sample forms and diagrams for records of tests, illustrations of computation sheets and strain test diagrams, formulas for slide rule calculations, and diagrams of machines and materials used in testing.

Turbine Design.

Reviewed by Storm Bull.*

TURBINEN UND TURBINENANLAGEN.—By Viktor Gelpke. Berlin, Germany: Julius Springer. Cloth; 7¾ × 11 ins.; pp. 181; 52 illustrations in the text and 31 folding plates. 15 marks; American price, $6.

The author of this book was for some years chief engineer of the well-known firm of Escher, Wyss & Co., of Zurich, Switzerland. When the high reputation of that firm, especially in the line of turbine design, is remembered, one has the right to expect a good deal from this book. Let it be stated at once that such expectations are more than fulfilled, as Mr. Gelpke's book furnishes a wealth of information, both practical and theoretical, which can be found nowhere else.

The book is divided into two main parts: the theory and the design of turbines and turbine power plants, these main divisions being again subdivided into numerous chapters. First comes the computation of the areas of the sections of the buckets, etc. This is one of the most important parts of the book, as it gives in detail, accompanied with numerical examples, the methods used by Escher, Wyss & Co., which methods were worked out by the author and adopted by that firm. There can be no doubt that the adoption of these methods has contributed very largely to the excellence of the outputs of the factory, the efficiency of the turbines of this firm having reached a limit beyond which it is almost impossible to hope to go. It is, however, also very apparent from this chapter how much time and labor must have been spent in making these computations for the size of the required sections of the buckets throughout their whole length, in order that such results may be accomplished. Nothing is here left to guesswork, although of necessity an initmate knowledge of the frictional resistances is one of the requirements of a successful designer of turbines.

The next chapter treats of the relations of pressures and velocities in turbines. Here will be found the main theory of the turbines as well as the characteristics of the various classes of turbines as affected by pressure and velocity. The choice of the angles both at entrance and at exit is discussed very thoroughly, also the influence of the draft tube; and again many numerical examples accompany the discussions.

In the next chapter the author gives detailed rules, always accompanied by a thorough-going discussion, for the design of the various classes of turbines. He begins with the Francis turbine, which in late years has become the most important one all over the world. The rules are given with such a precision and with such a wealth of tables that every designer of turbines owes Mr. Gelpke a debt of gratitude. Then follows the radial turbine with outward flow, and the axial turbine, of which latter the author states that he sees no reason why this type is not capable of as high a development as the Francis turbine. He then briefly discusses the impulse turbine as invented by Girard, and treats in detail the Pelton wheel and its modifications. It should be noted that Mr. Gelpke treats the Pelton wheel—as it should be—not as a waterwheel, but as a turbine.

In the second part of the book the author first discusses the conduits, etc., taking the water to and away from the turbine. Here he gives a large amount of practical information bearing directly upon the installation of a turbine power plant, which statement also applies to the following two rather short chapters on the arrangements for the purification of the water and on the methods for shutting off the water from the turbines.

The last chapter of the book treats of the mechanical details of the turbines proper, especially as answering the purposes for which the turbine is to be installed.

The author states in the preface that, through lack of time, he has found it impossible to take up the question of the regulation of the speed of turbines for discussion in this edition of the book, but that he hopes to do so in the near future; which hope every reader of the book no doubt will endorse.

The book, although very much condensed, is very clearly written and the illustrations, both in the text and on plates, are of very superior order. It should be in the possession of every one interested in turbines.

*Professor of Steam Engineering, University of Wisconsin, Madison, Wis.

A PLUMBING CATECHISM.—Or, The Theory and Practice of Plumbing Design in Question and Answer. By Chas. B. Ball, M. Am. Soc. C. E., and H. T. Sherriff, A. B., Editor of Domestic Engineering. Chicago, Ill.: Domestic Engineering. Cloth; 4½ × 6¾ ins.; pp. 100. $1.

There is here presented in small compass an epitome of the best plumbing practice in the United States. The main divisions of the "Catechism" are Plumbing Fixtures, Water Service Pipes, and the Design of Pipe Systems. There are a few paragraphs, in addition, on Pumps and on the Effect of Freezing. To the information regarding the authors which we have copied from the title-page it may be added that Mr. Ball was for a number of years Inspector of Plumbing at Washington, D. C., and in that capacity did some remarkably good work and gained valuable experience.

DIE AUSNUTZUNG DER WASSERKRAEFTE.—By E. Mattern. Leipzig, Germany: Wilhelm Engelmann. Paper; 6⅝ × 9½ ins.; pp. 260; 66 figures in the text. 7 marks; American price, $2.80.

In the view that the main problem of water-power development lies not in the design of the generating machinery, but in the general plan of the works and in the study of local hydrological and topographic conditions and the like, the author endeavors to present a discussion of the elements of this problem. He has produced a collection of notes, as it were, the skeleton of a treatise. The first half of the book considers the technical features of hydraulic power development: available precipitation and flow; head, and means for securing it; location, etc., of the generating station; transmission of power; steam auxiliary stations. Under the heading Economic Factors In Hydraulic Developments he then considers the cost and value of water-powers, the yield of power enterprises, and associated matters. The last section, occupying a third of the volume, is headed Modern Tendencies In the Utilization of Water-powers; here separate chapters are devoted to Switzerland, Austria, Italy, France, Sweden and Norway, England, America, and Germany, giving general reviews of recent work in those countries, and sketching the local modifying conditions.

THE STATE ENGINEER AND HIS RELATION TO IRRIGATION.—By R. P. Teele, Expert in Irrigation Institutions. Bulletin No. 168, Office of Experiment Stations, U. S. Department of Agriculture. A. C. True, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 99.

Most of the western states in which irrigation is practiced have state engineers. The principal duties of these officials relate to irrigation, or at least the water rights and distribution of water upon which irrigation so largely depends. This pamphlet takes up in order the states which have or have had engineers concerned with irrigation, and discusses under each state existing water rights, the acquirement of new rights, the distribution of water, and miscellaneous subjects pertaining to the office of state engineer. A brief general discussion follows the review by states, and in conclusion there is a tabular summary of the public control of water and of the leading facts relating to irrigation officials in the arid states, all as existing in 1905.

THE AMERICAN STEEL WORKER.—A Twenty-five Years' Experience in the Selection, Annealing, Working, Hardening and Tempering of Various Kinds and Grades of Steel. By E. R. Markham. Second Edition. New York: The Derry-Collard Co. Cloth; 5¼ × 8 ins.; pp. 339; 163 figures, mostly in the text. $2.50.

This edition of the book contains a short chapter on "High Speed Steels," otherwise it is a reprint of the first edition (Reviewed June 12, 1903). It is a better piece of book making than the original, however, being printed on better paper and being better bound.

BATTER TABLES.—For 192 Batters from 1/16-in. to 3/16-in., to 12 ins. per ft., giving Altitude of Pothenuse in Feet and Decimals of Feet for Base Measured in Feet, Inches and Sixteenths; a Table of Equivalents of Inches and Fractions Decimals of a Foot. By C. G. Wrentmore, Assoc. M. Am. Soc. C. E., Asst. Prof. Civil Engineering, University of Michigan. New York: Engineering News Publishing Co. Cloth; 8 × [illegible] one table on front cover flap. $5, net.

The scope of these tables is indicated [illegible] sub-title, given above. The author states, [illegible] Preface, that the tables are presented [illegible] supplement, rather than take the place of [illegible] of squares and logarithms. He also expresses [illegible] belief that they will save not only time and labor but also many errors. For a book of the type is unusually large, which, of course, favors ease of reference.

SPECIAL HAZARDS AND FIRE RECORD.—Quarterly Bulletin of the Committee of the National Fire Protection Association, No. 15, October, 1905. Henry A. Fiske, Chairman Committee. Hartford, Conn.: (Address the Chairman). Paper; 8 × 11 ins.; [illegible] pp. 84; text illustrations and one folding plate.

The quarterly bulletins issued by the committee named above often contain much interesting and valuable descriptive matter relating to various machines, industrial processes and the like. In the bulletin before us, 15 pages are devoted to grain elevators, including text and illustrations describing their construction and the grain-cleaning and other machinery forming their equipment. Other special articles in this number take up rubber-covered wire, iron and brass foundries, concrete and sand-lime brick as building materials, and the destructive distillation of bituminous coal.

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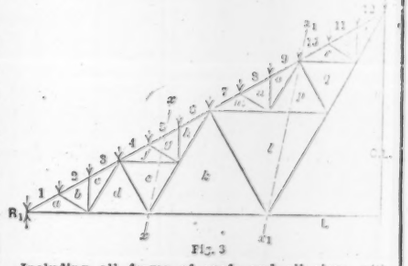

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Vol. I.: Electricity; Wiring; Telegraph.
Vol. II.: Generators; Motors; Storage Batteries, Automobiles.
Vol. III.: Electricity; Light; Power; Railways.
Vol. IV.: Alternating Current Work; Transmission.
Vol. V.: Telephony.
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Vol. X.: Machine Shop; Tool Making; Forging.
Vol. XI.: Mechanical Drawing; Perspective.
Vol. XII.: Ventilating; Heating; Plumbing; Carpentry; Index.

The dozen well-bound books before us are given the general title of "Modern Engineering Practice." As may be surmised from the name of the publisher, these volumes are really the collected instruction papers of the American School of Correspondence, or rather of selections from those papers, since the elementary papers on such subjects as arithmetic and other common school studies are not included.

As may be gathered from the titles to the several volumes no attempt is made to cover the entire field of engineering practice. Practically no attention is given to what is usually called civil engineering work or to mining engineering. The amount of space devoted to each subject, moreover, has little relation to its general importance on the whole field of engineering. There is, for example, in Vol. VIII. an instruction paper on "Navigation," but the whole twelve volumes, as far as we find, contain nothing on "Surveying."

A natural result of bringing together a lot of separate instruction papers is that the same subject is treated in two or more different places. For example, in Vol. I., the first instruction paper, on "Elements of Electricity," devotes 13 of its 52 pages to telephony, a subject which is again taken up in Vol V., and to which in fact that entire volume is devoted. Similarly, as above noted, "Boilers" are discussed in two separate volumes.

It need hardly be said that in the limited space devoted in these books to any single subject, nothing more than a skeleton outline of its elements can be given. For example, Vol. VIII. contains 222 pages on railway engineering, of which 103 are devoted to Locomotive Boilers and Engines and 64 to the Air Brake. We are not clear what useful purpose such a smattering of knowledge as can be given in such a limited space will serve. Men in actual railway service are already acquainted with most of the elementary matters covered in these pages, and the more intricate subjects, such as computing counterbalances and designing valve gears, are beyond them, and are in fact matters with which they have nothing to do. Similarly, in the matter of air brakes, the instruction book of the Master Car Builders' Association appears to us to cover the subject in more practical shape for trainmen's instruction. In the field of applied electricity, to which much more space is given, it is probable that more adequate treatment of the subjects covered has been possible.

GEOLOGY AND UNDERGROUND WATER RESOURCES OF NORTHERN LOUISIANA AND SOUTHERN ARKANSAS.—By A. C. Veatch. Professional Paper No. 46, U. S. Geological Survey. Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11¾ ins.; pp. 422; 51 plates and 33 text figures.

The portion of this large "Paper" of most practical interest to engineers and contractors is a chapter of 20 pages on "Methods and Cost of Well Making." Under "Methods" there are given both general information and also descriptions of the practice and apparatus used in the district reported on. Costs of deep wells in different geological formations in Arkansas and Louisiana are given in tabular form, the information including location, depth, diameter, size and length of casing, total cost, average cost per foot with and without casing, year drilled, and remarks. A longer chapter than the one just described is devoted to "Underground Water Prospects, by Counties." This is followed by a chapter headed "Detailed Well and Spring Records," which gives in tabular form the location, owner, driller and dimensions of wells, with height of water above or below the ground, and other information of more or less interest.

PRACTICAL ARBORICULTURE.—How Forests Influence Climate, Control the Winds, Prevent Floods, Sustain National Prosperity. A Text-Book for Railway Engineers, Manufacturers, Lumbermen and Farmers. How, Where and What to Plant for the Rapid Production of Lumber, Cross-Ties, Telegraph Poles and Other Timbers. By John P. Brown, C. E. Connersville, Ind.: The Author. Cloth; 6½ × 10¼ ins.; pp. 454; many plates and text illustrations. $2.80.

Mr. Brown is well known to many as an apostle of tree planting in general and of planting the Catalpa Speciosa in particular. He here brings together a large number of articles and addresses, principally articles, on two main classes of subjects indicated in his sub-title: forestry in its broader aspects and tree-planting for specific purposes. Interspersed with his essays on these topics are a number of others on particular species of trees and still others on such subjects as a trip to the Yosemite valley and a trip to Old Mexico, having more or less relation to the main topic of the book. The volume abounds with illustrations, most but not all of which are pertinent to arboriculture, all of which are interesting and some of which are particularly handsome half-tone plates, reproduced from well chosen photographs. Most if not all of the matter composing the book has appeared in "Arboriculture," but some of it was originally prepared for addresses before public gatherings.

The work can in no proper sense be called a text-book, since it is utterly lacking in systematic arrangement, but it will doubtless prove of no little educational value. Its useableness if not its usefulness would have been increased by a proper classification of its contents, but perhaps the present arrangement, or lack of arrangement, will appeal more strongly than any other to the general public, and it is there that its mission chiefly lies.

As would be expected, the one subject that receives most attention is the Catalpa Speciosa, its merits, uses and propagation. On this subject the author speaks with the authority of great experience.

It is a pity that the book has no index, what is called such being merely a table of contents.

INTERNAL ENERGY.—A Method Proposed for the Calculation of Energy Stored within Matter. By John V. V. Booraem, M. Am. Soc. M. E., Graduate of the Polytechnic School of Carlsruhe, 1859 (204 Lincoln Place, Brooklyn, N. Y.). New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 144; illustrated. For private distribution only.

The subject of this book and its method of treatment will naturally be of interest to an extremely limited circle of readers, practically only those interested in the highest researches in physical chemistry. The general purpose of the author is to suggest a simple working hypothesis whereby the amount of chemical energy which is stored within any body may be estimated. The method as devised was first applied to the two elements iron and copper; later it was applied to Muntzmetal. The results found were strikingly similar and evidently tended towards an expression of a constant gaseous coefficient of expansion at a rate of 1-273 per degree. Later, experiments were made with six metals, including zinc, tin, bismuth and lead. The latent heats of vaporization were also determined. Eventually the study turns to the development of chemical energy and its measure.

EARTHWORK COMPUTATION.—Slope Stakes and End Areas. By Walter S. Wheeler, Civil and Electrical Engineer. Seattle, Wash.: The Author. Paper; 4¼ × 5¾ ins.; pp. 8; five illustrations. 25 cts.

Five diagrams on as many pages are supplemented by three pages of explanatory text, designed to aid young engineers in the correct setting of slope stakes and in computing areas. The formulas, the author states in a separate communication, "are worked out from theory in Analytical Geometry."

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Tunnel Practice.

Reviewed by F. Lavis,* Assoc. M. Am Soc. C .E.

MODERN TUNNEL PRACTICE.—Illustrated by Examples Taken from Actual Recent Work in the United States and in Foreign Countries. By David McNeely Stauffer, M. Am. Soc. C. E., M. Inst. C. E., [Late] Vice-President Engineering News Publishing Co. New York: Engineering News Publishing Co. Cloth; 6½ × 9¾ ins.; pp. 314; 138 figures in the text. $3.50, net.

The purpose of this book is to present the latest developments in tunnel construction. With this end in view the author has compiled from various sources descriptions of various methods and appliances which have appeared from time to time in engineering journals and in the proceedings of technical societies. In so far as he has gathered together in convenient form a great deal of information which would be unavailable except after a long, tedious search, the book is to be commended. As stated in the preface, "The practice of tunneling in many of its important features has been radically changed within a comparatively short period" by the introduction of modern machinery, high explosives, etc.; and it is to be regretted that the author has neglected the opportunity to discuss the effect of these modern methods on cost and speed of construction.

It is a significant fact that it has seemed impossible up to the present time to approach even remotely in this country the speed of excavation attained in Europe, and especially in the long Alpine tunnels; culminating in the record in the Simplon tunnel of over 700 ft. in one month from a single heading and averaging a mile a year from each heading for six years. It is to be noted in this connection that in that tunnel, with the exception of the drills used in the headings, which were of the Brandt rotary hydraulic type, and the locomotives for hauling the material cars, no machinery was used in the tunnel, the drilling for the enlargement, from the heading to the full section, and all the mucking, being done entirely by hand. This points to conditions vastly different to those prevailing here, where hand drilling, on account of the high labor cost and scarcity of men, would be out of the question, and where steam shovels and other mechanical appliances for handling the muck are being largely introduced for the same reason. It would seem, therefore, that there is a need for a book on tunneling which would thoroughly discuss the relative economic value of these modern appliances, and the reasons for the comparatively poor showing as to progress in American tunnels; the author of the work under consideration makes no pretense of going into these questions, or of supplying the necessary data for their solution.

In none of the descriptions in English of the work on the large European tunnels which the writer has seen (and the description in the book under consideration of the work on the Simplon tunnel, which occupies nearly the whole of Chapter XIV., is no exception) has the effect on progress due to the better organization possible there, as well as the greater attention paid to ventilation, and the clearing away of the smoke and dust after blasting, received the attention it would seem to merit; and it is hoped that some writer on this subject with the necessary time, opportunity, experience, and familiarity with the European languages will take up this phase of the subject and discuss fully the reasons why, in spite of a largely increased use of very ingenious machinery for handling the debris, improved drills, explosives, etc., the progress on the majority of American tunnels to-day (at any rate in rock tunnels) is little if any better than that obtained on the Hoosac tunnel, completed 30 years ago, and on which the first power-drills were used in America. Another phase of tunneling which seems to have received scant attention at the hands of writers on this subject is the relative economic value of intermediate shafts. The author states (Chap. IV., p. 47) that

> at the present time shaft-sinking is largely confined to the extraction of minerals of various kinds and to the exploitation of city subways or subaqueous tunnels. . . . The use of high explosives, power drills and improved machinery for removing the debris have so increased the rate of progress in tunneling work that the old-time necessity for a number of shafts has largely disappeared.

This statement contains a certain element of truth but it is rather doubtful if in this country progress has been very much expedited by modern machinery, as it is probably a fact that the use of machinery has not kept pace with the difficulties of the labor situation. It is, nevertheless, probably true that, apart from their possible use for ventilation (which will not be as necessary in the future, owing to the extension of electrical operation), the sinking of shafts for the purpose of expediting the work by providing more points of attack is in many cases uneconomical, as the same results so far as time of construction is concerned might have been obtained for less money by pushing the work more rapidly from the ends. The subject is hardly one which can be dismissed, as the author has done, in a couple of sentences. The advisability or otherwise of sinking a shaft involves the consideration not only of the cost of the shaft itself and the necessary duplication of plant, or loss of power by transmission a long distance, but also the extra cost of speed higher than the normal, general effect of decreased cost of superintendence due to shorter time of work, etc.

The author has stated frankly in the preface that such discussions as those just mentioned are outside of the province of his book, and care therefore should be exercised by his readers to accept statements of this nature with some reserve. He has generally confined himself to short general descriptions of methods used in tunnels actually built, leaving the reader to make his own inferences as to their economy and applicability to other work of a similar character, and while this sort of information has its use, it is sometimes confusing to have set forth a half dozen different methods of accomplishing the same result without some discussion as to the reasons for the adoption of one in one place and another somewhere else, or the relative economy of one over another. With these reservations, however, the author is to be commended for the collection in one volume of a large number of interesting descriptions of various methods covering a wide range of conditions.

The first chapter provides a very brief discussion of some of the considerations affecting the location of tunnels and gives some notes on methods of alinement. Chapters II. and III. contain descriptions of various explosives, methods of blasting, etc., which are valuable, as indicating in a general way American practice in these matters. The remainder of the book, some 220 pages, with a Glossary of terms applied, is devoted to descriptions of various appliances, methods, etc., used in shaft sinking and tunnel building in various kinds of ground, methods of tunnel lining, etc., and some data of costs.

The purpose of the author, as previously stated, has been to present modern tunnel practice under as many varying conditions as possible, and in this he has generally succeeded, though one important feature in up-to-date practice, namely the steam shovel, seems to have escaped his notice, except for some data of costs in an open cut approach. The whole subject of tunnel building is so large that it is practically impossible within the limits of a book of this size to more than barely touch on the various features governing tunnel construction. As an instance of this may be noted the space devoted to the construction of subaqueous tunnels by the shield method, some thirteen pages, whereas the recently published work by Copperthwaite, devoted to this phase of the subject alone, contains nearly 400 pages of a much larger size.

Within the limitations imposed by the size of the book and with the reservation noted above, the author has made a very creditable compilation of the recent periodical literature on the subject, which is presented in an acceptable manner and quite profusely illustrated; the press work and make-up of the book is of the best type.

*Resident Engineer, Penn., N. Y. & L. I. R. R., 1 Baldwin Ave., Weehawken, N. J.

THE STEEL SQUARE AS A CALCULATING MACHINE.—Being Simple Directions for Using the Common Steel Square for the Solution of Complicated Calculations That Occur in the Everyday Work of Carpenters, Builders, Lumber Dealers, Plumbers, Gas Fitters, Engineers, Electricians, Tinsmiths, Blacksmiths, Masons, Stone Cutters, etc., etc. By Albert Fair. New York: The Industrial Publication Co. Cloth; 4¾ × 7½ ins.; pp. 81; illustrated. 50 cts.

THE STEEL SQUARE POCKET BOOK.—A Practical and Handy Treatise Giving the Best Methods of Using the Carpenter's Steel Square. By Dwight L. Stoddard. Second Edition, revised and enlarged. New York: The Industrial Publication Co. Cloth; 3¾ × 5¼ ins.; pp. 159; 150 illustrations in the text. 50 cts.

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HENLEY'S ENCYCLOPEDIA OF PRACTICAL ENGINEERING AND ALLIED TRADES.—A Work of Reference for the Mechanical Engineer, Designer, Draftsman, Shop Superintendent, Foreman and Machinist. Edited by Joseph Horner, A. M. I. Mech. E., Author of "Practical Metal Turning," etc. Vols. I. and II. (to be completed in five volumes). New York: The Norman W. Henley Publishing Co. Half morocco; 7 x 10 ins.; 480 pages in each volume; numerous plates and text illustrations. $6 per volume; complete set, five volumes, $25.

Neither the page nor preface indicate that the only thing American about this work is its New York imprint, but nearly every page bears strong evidence of British authorship. Most of the articles ignore American engineering works and practice, but as a rule other countries are equally ignored. These facts are not cited against the work itself, but merely to show its limitations.

The dictionary plan is followed, both in the arrangement and treatment of articles, and it is sometimes carried altogether too far. Thus we have "Atlantic Liners," under which ocean steamships are treated, and "Archbutt-Deely Process," which includes a general discussion of water softening. Then, too, there is an extensive article on "Babcock & Wilcox Boiler," and only three lines under "Boiler" itself. These lines give a general definition, and are followed by separate articles on "Boiler Efficiency," "Boiler End-Turning and Flue-Hole Cutting Machines," "Boiler Explosions," etc.

The encyclopedia, so far as it has progressed, is strongest in its mechanical and industrial engineering articles, as is perhaps to be expected. Some of the civil engineering material is located under strange headings, and some is very inadequate in scope. "Barrage" is given nearly three pages, largely descriptive of structures so-named quite locally, while under "Dam" there is but a half page of general matter, on masonry dams only. Under "Crowd Weights" only a definition appears. The article on "Bacteria Beds" is surprisingly good, especially by comparison, but contains some minor errors. One of these, in which it is stated that the Massachusetts State Board of Health experimented with intermittent filtration of sewage after chemical precipitation had been "tried and found wanting," is perhaps excusable; but certainly a British writer ought to give correct information on the requirements of the Local Government Board for the treatment of storm water.

The volumes received are good examples of book-making, but some of the line drawings would have been improved had they been prepared with a better understanding of the needs of photo-reproduction. Another improvement could have been readily effected by lettering the names of parts of machines on the drawings, instead of using reference letters, with the names all grouped together below.

Altogether, this new encyclopedia, thus far, is a commendable work, especially in view of the fact that the British "Spon" and the American "Knight's" and "Appleton's" have so long been out of date.

QUASI-PUBLIC CORPORATION ACCOUNTING AND MANAGEMENT.—By John F. J. Mulhall. Boston, Mass.: Corporation Publishing Co. Cloth; 6¼ x 9½ ins.; pp. 199; tables and illustrations. $5.

Inasmuch as the leading subject in this volume is water-works, and the section on that topic has been revised by Mr. William Wheeler, M. Am. Soc. C. E., of Boston, the book cannot fail to be of particular interest to many of our readers. Gas works, electric light plants, steam heating plants, telephone companies and electric railways are also taken up, but as a rule are treated in somewhat less detail in view of the fact that the section on water-works serves as a model for other forms of accounts. In the section on gas, there is reprinted the form of report required by the Gas and Electric Light Commission of Massachusetts. The author, it seems to us, might at least have referred to the exhaustive reports on accounting, including detailed schedules, made by committees of the gas and electric light associations.

For the most part, the various sections to which reference has been made deal with forms rather than principles of accounts. Many page headings for account books are shown. Some of the subjects covered in the section on water-works are application books, service and plumbers' cards, water, tap and service pipe bills, collector's report, house-to-house inspection and meter books, classification of revenue, etc., and various auxiliary books of record, such as those for gates, filters and meter testing.

Besides the chapters dealing specifically with accounts, there is one on securities, in which a number of forms for stock certificates, bonds, etc., are given, while other chapters deal with purchasing, sales, engineering, chemical and testing departments, and also the difficult subject of depreciation. Annuity, compound interest and sinking fund tables are given, and a few paragraphs are devoted to office devices. Altogether, the book seems to us to be a very creditable production, and one which should aid in much needed improvements in both municipal and private accounting for public service industries.

PRACTICAL ALTERNATING CURRENTS AND POWER TRANSMISSION.—By Newton Harrison, E. E., Instructor of Electrical Engineering in the Newark (N. J.) Technical School. New York: W. L. Hedenberg Publishing Co. Cloth; 5 x 7½ ins.; pp. 375; 172 illustrations in the text. $2.50.

This book represents one of the few successful attempts thus far made to discuss alternating currents without the use of mathematics. A few simple calculations are given, but in the majority of cases the conditions are expressed with reference to the principles upon which they rest. Numerous well-selected diagrams of a very unique character are used to impress upon the reader the various phases of alternating-current practice, and the tables given are almost as expressive as the illustrations. The subject has been treated from a power transmission and distribution standpoint. Much of the preliminary matter found in other books on the subject has not been introduced, although sufficient is given to afford the reader a good working knowledge of the subject. Practice rather than theory has been presented, and in clearness and originality of expression, neat press work, and general appearance, the book is a credit to both the author and publisher.

Of the fifteen chapters comprising the volume, the first two are devoted to conditions governing the different forms of electric lighting, the third and fourth to the factors entering into the various methods of alternating-current distribution; the fifth, sixth, and seventh, to the principles and performance of transformers; the eighth to thirteenth, inclusive, to alternators and a practical consideration of the current generated; the fourteenth to transformer testing and operation, and the fifteenth to definitions and formulas associated with alternating-current practice.

ELECTRICITY AS APPLIED TO MINING.—By Arnold Lupton, M. Inst. C. E., M. I. Mech E., M. Inst. E. E., late Professor of Coal Mining at the Yorkshire College, Victoria University, Mining Engineer and Colliery Manager; G. D. Aspinwall, Parr., M. Sc., M. Inst. E. E., Assoc. M. I. Mech. E., Associate of the Central Technical College, City and Guilds of London, Head of the Electrical Engineering Department, University of Leeds; and Herbert Perkin, M. I. M. E., Certificated Colliery Manager. Assistant Lecturer in the Mining Department of the University of Leeds. Second edition, thoroughly revised and enlarged. New York: D. Van Nostrand Co. London, England: Crosby Lockwood & Son. Cloth; 5⅝ x 9 ins.; pp. 320; 190 illustrations, mostly in the text. $4.50, net.

The aim of the authors of the present volume, according to the Preface, has been "to present to the reader the leading truths and main principles of electricity and electrical engineering without going into great detail, their intention being that he should have recourse for further information on the theory and practice of the subjects of Electrical and Mining Engineering to some of the many standard works already in existence."

Notwithstanding this statement, electrical theories and principles are dealt with at considerable length, more so in fact than in many treatises devoted entirely to electricity. Less than one-third of the book is given over to the applications of electricity to mining; consequently, if the authors had compiled the book in conformity with the Preface they would have had a volume of perhaps half the size of the present one. For the electrical engineer it is unfortunate that this was not done, as he is obliged to pay for and handle over two hundred pages that are of no practical use to him. For the mining engineer, colliery manager, or others who are contemplating the adoption of electricity for power or lighting and who know little or nothing of electricity, the book presents many valuable features, although even for them much unnecessary matter has been introduced.

One of the numerous examples illustrative of the statement just made is found in the chapter relating to the driving of the dynamo. There, under the heading of water-power, nearly two pages are devoted to a description of a hydro-electric plant near the Helvellyn Mountains, which is of local interest only. With but few exceptions, English machines and methods alone are illustrated and described.

IMPROVEMENT, REPAIR AND MAINTENANCE OF PUBLIC HIGHWAYS.—(Road Red Book, 1906.) Bulletin No. 12, Department of the State Engineer and Surveyor of the State of New York (Henry C. Van Alstyne, State Engineer and Surveyor). Albany, N. Y.: Pub. Doc. Paper; 5½ x 8½ ins.; pp. 360; plates and text illustrations and a large road map.

Instructions to local officials responsible for road building and maintenance are given, including sketches and descriptions of reinforced concrete culverts, of snow rollers, etc. The various statutes relating to the main subject of the bulletin are also given, and there is a long series of tables, by counties and towns, showing the road operations throughout the State in 1905. A large road map shows permanent road improvements already made, ordered and projected under State aid. The bulletin is particularly valuable in view of the $50,000,000 State loan for road improvement authorized recently by constitutional amendment.

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Surveying.

THE PRINCIPLES AND PRACTICE OF SURVEYING.—By Charles B. Breed and George L. Hosmer, Instructors in Civil Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 526; 192 illustrations, mostly in the text, and many tables. $3.

In this new attempt to meet the need for works on surveying, the authors have had in mind primarily the student (that is to say, the learner, not necessarily the college student). They have produced not a treatise, but a textbook, and an elementary rather than a comprehensive textbook. They deal with the simpler branches of the surveyor's work in a clear and simple explanatory style. The subject is covered in four main divisions, headed, respectively: Instruments (Use, Adjustment and Care); Surveying Methods; Computations; Plotting; followed by a rather good collection of tables. It is not necessary here to go into an analysis of the contents of these several parts, for the book is characterized and its scope determined at all points by the purpose which the authors had in mind. This is well illustrated by the section entitled "Plotting," comprising three chapters aggregating some 50 pp. The greater part of the contents of this chapter is matter for the instruction of the beginner who knows nothing of drafting in general or of survey mapping in particular. In the main these chapters are a condensation of what is given in special books on mapping and lettering, with additional remarks on paper, inks, and other tools. In the section on Surveying Methods much space is devoted to the very simplest difficulties of running line, etc.; but such a field full of knotty points as railroad surveying is altogether omitted (while on the contrary a chapter on mining surveying is given). The best single result of the authors' plan is the pointing out, at every new type of problem or for every new instrument, the special sources of error or the mistakes most commonly made. This feature should prove of much value in making the learner's work reliable and filled with fewer disappointments.

Minor criticism and commendation might be entered into, as with any new book, but to little purpose. We note with pleasure, for instance, that the advantages of the self-reading level rod are emphasized, and stress is laid on the possibility of highly accurate work with this rod; the barbarous target rod has long been an incubus on many phases of survey work.

The book is in excellent typographic form, and the neatness of the illustrations is to be commended.

Electrolysis.

AMERICAN GAS LIGHT ASSOCIATION.—Report of Committee on Electrolysis, 1906. [A. G. Glasgow, London, Chairman; John Williamson, Chicago; S. P. Curtis, Philadelphia; Arthur H. Hall, New York. Prof. Albert F. Gans, M. E., Consulting Engineer to Committee.] New York: The Association (George G. Ramsdell, Secy., 530 Broadway). Paper; 6½ × 9½ ins.; pp. 173; one folding plate and two text figures. 50 cts.

Although intended primarily for gas men, this very comprehensive report on electrolysis will doubtless be eagerly read by water-works men who have to contend with electrolysis. The report deals in succession with (1) The Theory of Electrolytic Corrosion; (2) Electrolysis in America, (3) in Great Britain, and (4) in Germany; (5) Summary and Conclusions. In the review of electrolysis in this country, reference is made to the report of Mr. Edwin A. Fisher, City Engineer of Rochester, N. Y., dated Aug. 1, 1901, for a comprehensive review of the American literature on electrolysis up to the date named. The committee then proceeds to review subsequent reports and investigations, beginning with a reprint of the Special Masters' Report on the suit brought by the Peoria Water-Works Co. in 1898 against the Electric Traction Co. in that city.

The section of the committee's report reviewing conditions in Great Britain is supplemented by reprints of various official documents dealing with electrolysis and allied subjects, including the model form for parliamentary bills granting powers to electric railways, and also including the Board of Trade regulations on the subject of electrolysis. The regulations just named, many Americans will be surprised to know, have been rendered of little value, in the opinion of the committee, through the allowance of seven volts difference in potential between rails and pipes. This allowance, combined with the fact that the Parliamentary Tramways Act relieves street railway companies of all responsibilities for damage by electrolysis, provided the companies use reasonable care in following out the Board of Trade Regulations, leaves the gas and water companies and municipal authorities virtually unprotected.

The portion of the committee report dealing with Germany gives the substance of the reports of the Electrolysis Commission of the German Society of Gas and Water Engineers for the years 1904 and 1905.

The "Summary and Conclusions" of the committee are presented in about eight pages. The committee believes that electric railways should be held responsible for all damages "caused by their overt failure to control their own currents"; that such companies should protect street piping from electrolytic damage by "completely insulated metallic circuits for all currents," and that where this is done they should be "especially exempted by ordinance from responsibility regarding electrolysis, *so long as they effectively maintain such circuits*"; but that where the electrolytic risk to pipes is small, rails under certain conditions may be used for the return current.

We have received from Mr. Nicholas Simin, Chief Engineer of the Water-Works of Moscow, Russia, a lengthy detailed description in Russian of the Moscow water-works, accompanied by a large portfolio of reproductions of drawings and photographs; also a paper in Russian on "The Water-Works System of Moscow," presented by Mr. Simin to the Sixth Russian Water-Works Convention (1903). Many of our readers remember with pleasure the visit of Mr. Smith to this country a few years ago.

STREAM POLLUTION BY ACID-IRON WASTES.—A Report Based on Investigations Made at Shelby, Ohio. By Herman Stabler. Water-Supply and Irrigation Paper No. 186, U. S. Geological Survey. Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 36; one plate.

After a brief general introduction, this paper describes the conditions which led to a suit for damages on the part of a farmer for the pollution of a small stream by wastes from the plant of the Shelby Steel Tube Co. The testimony in the suit is summarized and comments are made on the verdict, which was in favor of the farmer-plaintiff. The author next describes in a few paragraphs the city sewage works of Shelby, which consist of sludge basins, large settling reservoirs, and filter beds of cinders and gravel. The effect upon the sewage works of turning the tube mill wastes into the outfall sewer is presented by both text and table, and a plant finally installed by the company for recovering copperas from its pickling waste is described.

THE EFFECT OF COPPER UPON WATER BACTERIA.—By Karl F. Kellerman, Physiologist in Charge of Soil Bacteriology and Water Purification Investigations, and T. D. Beckwith, Scientific Assistant. Bulletin No. 100, Part VII., Bureau of Plant Industry: B. T. Galloway, Chief of Bureau. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 19; 33 tables.

The authors present considerable tabular matter designed to show that the use of copper sulphate in quantities sufficient to kill typhoid germs in water will not kill water bacteria needed to oxidize organic matter in the same water. They also pass briefly in review objections to copper sulphate as a germicide raised by numerous investigators, showing how, in the opinion of the present authors, the issues have been clouded by the other investigators. In conclusion they give a few sentences on the use of copper sulphate in connection with filtration, suggesting at what stage the salt should be added, the importance of carbon dioxide contents of the water in this connection, etc.

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The Production of Natural Gas in 1905. By W. T. Griswold. Pp. 18.

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ATTACKS OF THE HELLGRAMMITE ON WHITE OAK SUBMERGED IN FRESH WATER.—By Captain H. Burgess, Corps of Engineers, U. S. A. Observations Secured while Repairing Dam No. 1, Barren River, Ky., the Oak Timbers of Which Had Been Destroyed by This Insect. No. 22, Occasional Papers, Engineer School, U. S. A. Washington Barracks, D. C.: The Engineer School. Paper; 6 × 9 ins.; pp. 7; four illustrations in the text.

BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF IOWA.—Annual Report for the Year Ending June 30, 1905. Des Moines, Iowa.: Pub. Doc. Cloth; 5¾ × 9 ins.; pp. 448.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

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CENSUS OF MANUFACTURERS: 1905.—United States. Bulletin 57, Bureau of the Census. S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.; pp. 93.

(Also Bulletins 52-56, inclusive, Census of Manufacturers for Illinois, Massachusetts, New Jersey, Georgia and Wisconsin. Pp. 53, 79, 53, 23 and 39, respectively.)

CLAYS.—Their Occurrences, Properties, and Uses. With Special Reference to Those of the United States. By Heinrich Ries, Ph. D., M. Am. Inst. M. E., Assistant Professor of Economic Geology in Cornell University; author of "Economic Geology of the United States." New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 490; 65 text figures and 44 plates. $5, net.

COAL AND IRON MINES.—By Astolfo Bartoccini, Assoc. M. Am. Soc. C. E. Compañia Fundidora de Fierro y Acero de Monterrey, S. A. (Address the Author, 630 West 148th St., New York City.) Flexible leather; 6 × 9½ ins.; pp. 155; folding plates and many text illustrations.

THE COST OF LOCOMOTIVE OPERATION.—By George R. Henderson, M. E., M. Am. Soc. M. E. New York: The Railroad Gazette. London, England: The Railway Gazette. Cloth; 5½ × 9 ins.; pp. 192; 13 illustrations, partly in the text. $2.50.

THE DESIGN OF STEEL MILL BUILDINGS AND THE CALCULATION OF STRESSES IN FRAMED STRUCTURES.—By Milo S. Ketchum, C. E., Assoc. M. Am. Soc. C. E., Dean of the School of Applied Science, and Professor of Civil Engineering, University of Colorado. Second Edition, enlarged. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 464 + 16; numerous illustrations and tables. $4, net.

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ELEMENTS OF GAS ENGINE DESIGN.—By Sanford A. Moss, M. S., Ph. D., M. Am. Soc. M. E., Engineer, General Electric Co. Reprint of a Set of Notes Accompanying a Course of Lectures Delivered at Cornell University in 1902, and of Articles from "American Machinist," "Machinery" and "Power." With Additions. No. 121, Science Series. New York: D. Van Nostrand Co. Boards; 3¾ × 6 ins.; pp. 197. 50 cts.

THE ENERGY CHART.—Practical Applications to Reciprocating Steam-Engines. By Captain H. Riall Sankey, R. E. (ret.), M. Inst. C. E., M. Inst. M. E. Rugby, England: Albert Frost & Sons. Cloth; 5½ × 8½ ins.; pp. 170; 157 illustrations in the text and one folding plate.

ESSAIS DE COMPTEURS D'EAU.—By M. A. Perot, Directeur du Laboratoire d'essais, and M. H. Michelevy, Assistant. Bulletin No. 8, of the Testing Laboratory of the Conservatoire National des Arts et Métiers. Paris, France: Ch. Béranger. Paper; 6½ × 10 ins.; pp. 28; six plates and six text illustrations.

EXPORTERS' ENCYCLOPEDIA, 1907.—Containing Full and Authentic Information Relative to Shipments for Every Country in the World. New York: Exporters' Encyclopedia Co. (78 Broad St.) Cloth; 5½ × 8¼ ins.; pp. 633. $5.

INSTITUTION OF MINING AND METALLURGY.—Transactions, Fifteenth Session, 1905-1906. Vol. XV. Edited by S. Herbert Cox and William Gowland, Honorary Technical Editors, and C. McDermid, Secy. London, England: E. & F Spon, Ltd., and The Institution. New York: The Engineering and Mining Journal. Paper; 5½ × 8½ ins.; pp. 659; plates and text illustrations.

IRRIGATING SEDIMENTS AND THEIR EFFECTS UPON CROPS.—By R. H. Forbes. Bulletin No. 53, University of Arizona Agricultural Experiment Station. Tucson, Ariz.: The University. Paper; 5¾ × 9 ins.; pp. 58 to 98; illustrated.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE.—Vol. LXX., No. II., 1906. Edited by Bennett H. Brough, Secy. London, England: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 5½ × 8¾ ins.; pp. 325; 57 plates, text illustrations and many tables.

THE "MECHANICAL WORLD" POCKET DIARY AND YEAR BOOK FOR 1907.—Containing a Collection of Useful Engineering Notes, Rules, Tables and Data. Manchester, England: Emmott & Co., Ltd. Cloth; 4 × 6¼ ins.; pp. 399; 72 illustrations in the text, and many tables. 6d., net.

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NITRO-EXPLOSIVES.—A Practical Treatise Concerning the Properties, Manufacture, and Analysis of Nitrated Substances, Including the Fulminates, Smokeless Powders, and Celluloids. By P. Gerald Sanford, F. I. C., F. C. S., Public Analyst to the Borough of Penzance. Second Edition, Revised and Enlarged. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 5½ × 8¾ ins.; pp. 300; 60 illustrations in the text. $4, net.

PRACTICAL INFORMATION FOR BEGINNERS IN IRRIGATION.—By S. Fortier, Irrigation Engineer. Farmers' Bulletin No. 263, U. S. Department of Agriculture. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 40; 25 illustrations in the text.

RECEIPTS AND EXPENDITURES OF ORDINARY REVENUE, 1901-1905.—Special Publications No. 13, Statistics Department, City of Boston. Boston, Mass.: Pub. Doc. Paper; 9¼ × 11¾ ins.; pp. 161; one folding sheet.

STREAM FLOW AND WATER POWER INVESTIGATIONS OF THE UNITED STATES GEOLOGICAL SURVEY IN MICHIGAN.—By Robert E. Horton, District Engineer, U. S. Geological Survey. Reprint from "Michigan Engineer," 1906. (Address the Author, 10 Providence Place, Albany, N. Y.) Paper; 6 × 8¾ ins.; pp. 20; eight illustrations in the text. 25 cts.

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TEXT-BOOK ON THE STRENGTH OF MATERIALS.—By S. E. Slocum, Ph. D., Professor of Applied Mechanics in the University of Cincinnati, and E. L. Hancock, M. S., Assistant Professor of Applied Mechanics in Purdue University. Boston and New York: Ginn & Co. Cloth; 6 × 9½ ins.; pp. 314; 170 illustrations, mostly in the text. $2; by mail, $2.15.

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UNIVERSAL DICTIONARY OF MECHANICAL DRAWING.—By George H. Follows, Associate Professor of Machine Design and Mechanical Drawing, Carnegie Technical Schools, Pittsburg. New York: The Engineering News Publishing Co. Cloth; 10¾ × 8¼ ins.; pp. 60; 45 illustrations in the text. $1, net.

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TURBINE WATER-WHEEL TESTS AND POWER TABLES.—By Robert E. Horton. Water-Supply and Irrigation Paper No. 180, U. S. Geological Survey: Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 134; two plates, 33 text figures and many tables.

The author states that this "is mainly a compilation of data derived from tests and from manufacturers' power tables of American stock sizes of turbines," to which he has added selections from the bibliography of his subject. The paper contains, however, brief historical and technical descriptions of various classes of turbines, accounts of the tests from which test data have been taken, and not a little practical information of various sorts in addition.

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The recent rapid increase in the price of platinum (to $34 per ounce in September, 1906) will render this pamphlet of interest to many. The author reviews the range of prices within the past two months or so, states where platinum is found in the United States and in other parts of the world, describes the methods of extraction employed in Russia and in the United States and the physical properties of the metal, and concludes with statements regarding the production, imports and uses of the metal and a brief bibliography.

THE LOCAL GOVERNMENT OFFICER.—With Which Is Incorporated the Public Health Engineer. The Official Organ of the National Association of Local Government Officers. Vol. I., No. 1, Sept. 8, 1906. London, England: The Editor (50-52 Ludgate Hill, E. C.). Paper; 7¾ × 12 ins.; pp. 36; illustrated. 3d.

This journal succeeds "The Public Health Engineer," which has been published in London for a number of years, and has given attention to municipal engineering and sanitation, and allied topics.

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